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THE HEPATICAE OF THE EAST COAST OF HUDSON BAY

(NOTES ON NEARCTIC HEPATICAE, II)

By
R. M. Schuster

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FOREWORD

This report by Dr. Rudolf M. Schuster, Instructor in the Department of Botany, University of Minnesota, is the result of a study of an important collection of liverworts made on the eastern part of the Canadian tundra. It fills a very large and important gap in the information regarding Hepatic distribution. It essentially covers those Arctic areas south of this region recently described by Polunin in Bulletin 97 of the National Museum of Canada.

In the report some 75 species are referred to, several of which are new to continental North America, and two new varieties are briefly described.

The study is based on material collected by Dr. John Marr in 1939, while a member of the University of Minnesota Expedition to Hudson Bay, and on a smaller collection made in 1948 by him in the Ungava Bay region. Dr. Marr is now Professor of Botany at the University of Colorado, Boulder, Colorado.

F. J. ALCOCK,
Chief Curator

OTTAWA, June 3, 1950

THE HEPATICAE OF THE EAST COAST OF HUDSON BAY

(NOTES ON NEARCTIC HEPATICAE, II)

By R. M. Schuster

Department of Botany, University of Minnesota[1]

INTRODUCTION

In the preparation of any manual of the Hepaticae of eastern North America, the Hudson Bay region represents a large lacuna in our knowledge of distribution of species. Until publication of the paper by Wynne and Steere (1943), there was virtually nothing in the literature on the Hepatic flora of that region.

The following report, based on collections made by Dr. John Marr in 1939[2] and 1948, should prove of some significance as regards elucidation of phytogeographical problems. Although almost all of the 30 species reported by Wynne and Steere have been identified in the present collection, a large number of other species have been found of considerable interest, among them *Scapania calcicola* var. *ligulifolia*, *Scapania degenii* and *parvifolia* (new to North America), *Lophozia* (*Orthocaulis*) *atlantica*, *Cephaloziella alpina*, *Tritomaria scitula*, *Plectocolea subelliptica*, *Marsupella sparsifolia*, *M. arctica*, etc.

The region treated here is somewhat greater than that treated by Wynne and Steere, and I have also included reports of species from the Ungava Bay area, east of Hudson Bay. In addition, I have taken into account the Hepaticae reported by Lepage (1945) from Rupert River region, near the southeastern corner of Hudson Bay (James Bay). I have included in the present treatment the general area from 65° to 80° longitude and 50° to 60° latitude. This covers the northern two-thirds of Quebec, the Belcher Island region (belonging to the Northwest Territories), and a small segment of Ontario. From this general area, Wynne and Steere (1943) report 30 species of Hepaticae, and Lepage (1945), 34 species. Together, these two lists establish the presence of 48 species of Hepaticae in the area. The present collections raise the total to 88 species. Further collections should establish at least another 50 species for the area. The region thus covered is characterized essentially by an Arctic flora—except for parts of the interior. No attempt has been made to gather together the few scattered previous references of Hepaticae north of this region, because a comprehensive paper by Polunin (1947) treating the thallophytes and bryophytes covers the entire eastern Canadian Arctic, north of latitude 60° N.

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[1] Contribution from the Herbarium of the University of Minnesota No. 15.

I should like to acknowledge here the courtesy of Dr. E. C. Abbe in making available the materials here studied, as well as the funds from the Graduate School of the University of Minnesota, that made possible the completion of this paper. The cost of the included illustrations has also been defrayed by funds provided by the Graduate School of the University of Minnesota.

In the assembling of the data presented and in the stenographic work, I have received the help of my wife, Olga M. Schuster.

[2] While a member of the University of Minnesota Expedition to Hudson Bay. *See* Science 90 : 458. 1939.

A note on the material available may be of interest. The plants here reported on were collected by Dr. John W. Marr: the 1939 collections while working with Dr. E. C. Abbe and the 1948 collections (from Ungava Bay) on an expedition of his own. The extremely rich Belcher Island material was all collected within about three days and for the most part when pressure of other work (collection and preparation of vascular plants) permitted. The specimens are therefore often quite sparse. In some cases, only 3 or 4 individual plants came to my attention, and determination of such fragmentary materials often was an extremely difficult matter (and one that had to be given up in many cases). An extreme example may be cited: in *Marr 661* (Great Whale River), a small collection of a few square inches contained a great abundance of *Cephalozia leucantha*, a few plants of *Cephalozia pleniceps* and *loitlesbergeri* (the latter finally determinable only after a single fertile plant could be located), a few small plants of *Lophozia kunzeana*, a rather large number of plants of *Lophozia wenzelii*, a few plants of *Mylia anomala*, several plants of *Calypogeia muelleriana* and of *Riccardia pinguis*, *Geocalyx graveolans*, *Cephaloziella elachista*, *Lophozia grandiretis*. (In other words 11 species could be identified on the basis of a collection some 8 square inches in extent.)

It is apparent, therefore, that the total quantity of material often was not sufficient to enable a definite determination to be reached. This has been especially the case with the extremely difficult *Cephaloziella* species, where often only enough material was found for a small slide. In such cases where the determination must remain doubtful, a question mark is indicated after the name of the species.

Many of the fragmentary specimens are such that they can be determined by the specialist whose familiarity with the material often allows him to go by general appearance (facies) as much as by specific microscopic characteristics. In the case of such collections, where either the material was so fragmentary as to make it improbable that enough could be scraped together from the specimen for further study or where the material was a little atypical, I have indicated the critical characters noted from the dissection at hand. In such cases I have also usually given specific reasons why the specimen was placed where it was. It is believed that such a procedure is almost necessitated here, in order to properly establish reports based on such fragmentary specimens. In many cases all of the plants that could be found were mounted on one or two slides; the first slide of any such preparation will in all cases be found in the University of Minnesota herbarium.

Subclass *JUNGERMANNIAE*[1]

Order **Jungermanniales**

Suborder JUNGERMANNINAE

Family LOPHOZIACEAE[2]

1. Lophozia (*Orthocaulis*) **kunzeana** (Hueb.) Buch

QUEBEC: "Dry arkose hillside east of The Narrows, Cairn Island, Richmond Gulf," *Marr 636, July 3, 1939* (among *Lophozia hatcheri, Ptilidium ciliare*). "Granite near the mouth of Great Whale River," *Marr 655, August 17, 1939* (with *L. atlantica, L.? wenzelii, Ptilidium ciliare, Mylia taylori*). "Margin of pool in raised sand beaches on south side of mouth of Great Whale River," *Marr 661, August 21, 1939* (among *Cephalozia leucantha, Lophozia wenzelii, Cephalozia loitlesbergeri, C. pleniceps, Mylia anomala, Calypogeia muelleriana, Riccardia pinguis*). "Shaded moist granite near the mouth of Great Whale River," *Marr 662b, August 22, 1939* (with *L. ventricosa, Temnoma setiforme, Cephalozia bicuspidata, Mylia taylori, Ptilidium ciliare*); same data, *Marr 662* (with *Mylia* and *L. ventricosa* and *L. atlantica, Ptilidium ciliare, L. quadriloba, Cephalozia bicuspidata*). "Moist forest floor, Runway Bog, Fort Chimo Air Base, Ungava Bay," *MLP-48-19, July 8, 1948* (only a few plants, among *Pleuroclada albescens* var. *islandica, Bl. trichophyllum, L. ventricosa, Sc. irrigua*). (In Quebec previously reported from Cairn Island, Richmond Gulf, and, to the south, from Lake Mistassini; Rigaud; La Tuque; Mont Albert; *see* Lepage, 1945.)

In the Far North, where this species is often abundant, it may occur intermingled with *Pt. ciliare, Lophozia atlantica, Mylia taylori*, on granite walls (as at Great Whale River, Quebec).

When occurring with *L. atlantica* the two species may be easily confused, since their facies are rather similar. Robust plants of *kunzeana* may show mostly 3-lobed leaves, and then may be extremely similar. Under the microscope, the relatively obtuse leaf-lobes of *kunzeana* (often even narrowly rounded at apex) are extremely characteristic: those of *atlantica* and the related *binsteadii* and *attenuata* are by contrast quite acute usually (sometimes terminated by a row of 2 single cells). *L. kunzeana* also has the cells of the leaf-tips only 13-18 μ (*atlantica* 20-25 μ on an average), and in *L. kunzeana* there are well-developed underleaves, bifid to base, whose lobes are at least 4-6 cells wide at base; in *atlantica* the underleaves are vestigial and not present throughout in many cases: when well developed they consist of 3-4 cilia, of which the outer 1 or 2 consist of only 1-2 cells, terminated by a slime papilla; the inner cilia are a single cell wide to the base (rarely 2) and are only 3-8 cells long. *L. kunzeana* bears gemmae on unreduced leaves: much the same condition as may occur in *atlantica*. In *kunzeana*, furthermore, the ventral merophytes are generally 8-12 cells wide; in robust stems of *atlantica* only 5-6 cells broad, in most cases.

[1] The family classification follows Schuster (1951; in press).
[2] The nomenclature in this family after Schuster (1951).

2. **Lophozia** (*Orthocaulis*) **floerkei** (Web. & Mohr) Schiffn.

QUEBEC: "Island near mouth of Seal River," Cape Jones, *Marr 676, September 3, 1939* (among *Anthelia juratzkana, Tr. scitula, Sc. curta, Bl. trichophyllum, L. hatcheri, L. heterocolpa, C. pleniceps*). "On wet rocks beside stream, Fort Chimo Air Base," Ungava Bay, *MLP-48-50, July 17, 1948* (scattered plants, among *Saccobasis, Preissia, L. bantryensis, Bl. trichophyllum*). (Also reported from Great Whale River, *see* Wynne and Steere, 1943, Lepage, 1945; to the south occurring again at Montreal, Mont la Table; *see* Lepage, 1945.)

NORTHWEST TERRITORIES: "Muck on diabase trap, near Hudson's Bay Co. Post, Tukarak Island," *Marr 664* (var. *densifolia* Nees), *August 27, 1939* (with *O. macounii, Tr. scitula, L. heterocolpa, Pl. asplenioides*).

The plants of *Marr 664* represent an extreme form of the species and are tentatively referred to the forma *densifolia* of Nees. The plants are merely 5-8 mm. high, appear terete because of the densely imbricate, strongly concave, erect leaves; the plants are nearly erect in growth. In Frye and Clark (1945, pp. 401-402) the specimens would key to *O. atlanticus*, because of the unfortunate selection of key characters in that work. The plants, however, are clearly *floerkei* for the following reasons: the under leaves are nearly as long as the leaves, lanceolate or bifid; the leaf-cells are mostly 16-18 μ along the margins of the leaf-lobes. The material approaches *atlantica*, however, in that the underleaves though large and bilobed have only 1 or at most 2 short cilia and in that the postical leaf-bases are entire or bear a single, stalked, slime papilla. It is apparent, therefore, that the use of the development of cilia of the underleaves and the presence or absence of cilia of the postical leaf-bases cannot be used as a consistent separation between the two species. The larger leaf-cells of *atlantica* (19-25 μ along the margins, occasionally even larger), together with the fact that the underleaves are at best one-quarter the length of the leaves and consist of 1-4 cilia only a single cell wide, afford a safe separation from *floerkei*. In *atlantica* the ventral stem sectors are a maximum of merely 4-5 cells broad; in *floerkei*, judging by the basal width of the underleaves, they are 6-8 or even 10 cells broad, only on occasional shoots 5 cells broad.

The present collection is quite aberrant in that the cuticle is coarsely papillose: generally only 3-4 large papillae occurring per leaf cell (much as in the closely related *L. quadriloba*). Macvicar (1926) uses the supposed smooth cuticle of *floerkei* as one of the separating characters from *quadriloba*. As appears evident, no such separation can be maintained. It is possible the present plants should be set off as a separate variety, because of the coarsely papillose cuticle (much as Buch set off the coarsely verrucose form of *Diplophyllum taxifolium* as the var. *macrosticta*); the type of Nees' *densifolia* should, however, be examined as regards this characteristic. The leaves of the present form differ not only in being coarsely papillose and in almost constantly lacking postical cilia but are also distinctive in being quite transverse. In typical *floerkei* the leaves vary from about 1·1-1·2 as wide as long (and look quadrate); in the present collection the leaves (where 3-lobed) vary from 1·3-1·5 as wide as long and are considerably more transverse in appearance.

Müller (1910, p. 640) stresses the fact that *floerkei* is rare in calcareous areas and states "in Kalkgebirgen ist sie meistens viel seltener und lebt nie unmittelbar auf Felsen. . ." The present collection again is of interest here, since the plants occurred on thin soil over diabase, with other such basiphytes as *Tritomaria scitula*, *Lophozia heterocolpa*, *Odontoschisma macounii*, *Scapania calcicola* var. *ligulifolia*, *Plagiochila asplenioides*: plants very typically occurring under circumneutral conditions. (The same association of species, except for *L. floerkei*, occurs again on the diabase of Cook and Lake Counties, Minnesota; here the pH range was found to be from 5·5 to 7·0.)

The material of *Marr 664* thus approaches *quadriloba* in (1) the broader leaves, (2) the sinuses descending one-third to one-half the leaf-length, (3) the olive-green, dull colour, (4) the coarsely verrucose cuticle. Such plants are so nearly intermediate they are virtually impossible to place.

3. **Lophozia** (*O.*) **atlantica** (Kaal.) K.M.

Quebec: "Moist shady locality above a temporary snowbank near the Narrows, Cairn Island, Richmond Gulf," *Marr 630, June 29, 1939* (with *Cal. trichomanis*, *Mylia anomala*, over *Sphagnum*). "Granite, near the mouth of Great Whale River," *Marr 655, August 17, 1939* (with *L. kunzeana*, *L. wenzelii*, *Ptilidium ciliare*, *Mylia taylori*); same data, *Marr 662, August 22, 1939* (with *Mylia taylori*, *L. ventricosa*). "Shaded moist granite near the mouth of Great Whale River," *Marr 662a, August 22, 1939* (among *Mylia taylori* (Hook.) Gray, *Lophozia ventricosa* (Dicks.) Dum.). "Manitounuck Sound, island between Boat Opening and Schooner Opening," *Marr 648a, August 14, 1939* (with *Mylia taylori* (Hook.) Gray). "Crevices in moist granite, near the mouth of Great Whale River," *Marr 656a* and *c*, *August 17, 1939* (with *Mylia taylori* (Hook.) Gray, *Lophozia* ? *confertifolia* Schiffn. and *Pleuroclada albescens* var. *islandica*. "Dry river terrace, about 80 miles up the Leaf River," near Ungava Bay, *MLP-48-95, August 15, 1948* (material with very few underleaves, approaching *L. binsteadii*; with *L. ventricosa*, *Cephaloziella* sp.). Previously reported by Lepage (1945) from Rupert River; also recorded by Polunin (1947) from the Arctic region to the north.

The plants certainly belong here because of the relatively large leaf-cells, which average 26-27 μ in the leaf-lobes and along the leaf-margins of the lobes. The leaves in *Marr 662*, however, are not, or are scarcely, wider than long (when 3-lobed), only the occasional 4-lobed leaves being wider than long. In the leaf-shape, therefore, the collection more closely approaches *L. binsteadii*, which, however, has smaller leaf-cells and lacks underleaves totally. Small underleaves, consisting of 4-12 cells, could be demonstrated on the present plants, consisting of 2-3 cilia, each terminating in a slime papilla. The plants were gemmae-free.

The second collection (*Marr 655*) was more typical and showed the typically transverse leaves of *atlantica* very well, the three-lobed leaves being 1·2-1·5 as wide as long, and even the occasional 2-lobed leaves being slightly wider than long. This latter collection was of interest in that the postical (and sometimes also the antical) leaf bases often showed distinct cilia: usually only 1-2 cells long, terminated by a slime papilla. Basal cilia are of rare occurrence in the *attenuata-binsteadii-atlantica* complex.

The other collections (except for *MLP-48-95*) are of more abundant material, and one (Great Whale River) consists of a large tuft of plants with the erect, terete (but rather stout) gemmiparous shoots, which bore numerous metallic, deep purple gemmae at their apices. These collections also show the predominance of transverse, rather broad 3-lobed leaves, and show numerous minute underleaves.

The limits between this species and *L. binsteadii* are at present still not sharply defined. The writer has recently found material with the broad 3-lobed leaves of *atlantica* (and with cells equal to those of the present collection in size), but nearly totally devoid of underleaves, from New Hampshire (Mount Washington). In the collection of *Marr 662*, the leaves are clearly narrower (approaching *binsteadii*), with the lobes narrower; but the cell-size is large, and small underleaves occur. It is apparent, therefore, that there is room for subjective opinion as to where to draw the line, if any, between these two difficult forms. *L. binsteadii* is known from north of the area treated, in northernmost Quebec (Sugluk Inlet); *see* Lepage, 1945; Polunin, 1947.

4. **Lophozia** (*Barbilophozia*) **lycopodioides** (Wallr.) Cogn.

QUEBEC: "Richmond Gulf, near Fishing Lake Creek," *Marr 645a, August 3, 1939*. "Dry River terrace about 80 miles up the Leaf River," Ungava Bay, *MLP-48-96a, August 15, 1948* (with *P. ciliare*).

Lepage (1945) reports the species from Fort Chimo and Seal Lake, from Seal River, Cape Jones (in the region here treated); he also reports it from further southward, from near Montreal; Sainte-Anne de la Pocatière; Bic; Sacré-Coeur; comté de Rimouski; Rimouski; Mont Albert; Mont la Table. Polunin (1947) cites a single report of the species from north of 60° longitude, from Stupart Bay, Quebec. This report, however, dates to 1890 (Macoun, 1902, p. 21, based on a report by Pearson, 1890, p. 21), a period before the closely related *L. hatcheri* was split off; hence it must be considered as dubious until the specimen is re-examined. The species certainly must have a much wider distribution in the Far North, since it is a more strictly Arctic-alpine species than the related *L. hatcheri*, which is known north to Ellesmere Island.

The first collection (*Marr 645a*) represents an xeromorphic form with unusually imbricate and concave, brownish-pigmented leaves. The mature leaves have the cell-walls and bulging trigones brownish pigmented, except for the cilia and leaf-margins, which are decolorate and hyaline, and formed of very strongly thick-walled cells (forming a very discrete border). The plants do not have the leaves spreading horizontally but have them somewhat concave, strongly imbricate; forming terete, somewhat ascending shoots; appearing superficially closely similar to *L.* (*Orthocaulis*) *floerkei* or *Temnoma setiforme*.

5. **Lophozia** (*Barbilophozia*) **hatcheri** (Evs.) St.

QUEBEC: "Dry arkose hillside east of The Narrows, Cairn Island, Richmond Gulf," *Marr 636, July 3, 1939* (with *Ptilidium ciliare, Lophozia kunzeana*). "Island near the mouth of Seal River, Cape Jones," *Marr 674, September 4, 1939*; same data, *Marr 673*; same data, *Marr 676, September 3, 1939* (scattered among *Anthelia juratzkana, Tr. scitula, Sc. curta, L. floerkei,*

L. heterocolpa, C. pleniceps). "Base of large, live white spruce (MT 157) on raised sand beach, south side of Great Whale River," *Marr 652, August 17, 1939*. "On moist soil (sand), stream north of barracks area, Ft. Chimo Air Base," Ungava Bay, *MLP-48-46, July 17, 1948* (with *L. ventricosa, C. rubella*). "On dry rock surface, one mile north of Leaf River, at point about 80 miles up the river," southwest of Ungava Bay, *MLP-48-123, August 16, 1948*. (Also reported from Wakeham Bay and from Ivuyivik; further southward in Quebec also at Tadoussac; Rigaud; Bic; Islet Canuel, near Rimouski; Sacré-Coeur, comté de Rimouski; Mont la Table; *see* Lepage, 1945.)

6. **Lophozia** (*Barbilophozia*) **barbata** (Schmid.) Lske.

Quebec: "Arkose hillside near The Narrows, Cairn Island, Richmond Gulf," *Marr 633, June 29, 1939* (among *Ptilidium ciliare, Lophozia alpestris*). Manitounuck Sound "island between Boat Opening and Schooner Opening, *Marr 648, August 14, 1939* (with *Scapania degenii* (Schiffn.) and *Ptilidium ciliare* (L.) Nees). (It was also reported previously from Wakeham Bay, Seal River at Cape Jones, and from Cairn Island; *see* Wynne and Steere, 1943.)

Northwest Territories: "Near the Hudson's Bay Co. Post, Tukarak Island," Belcher Islands, *Marr 667, August 27, 1939* (a few scattered plants among *Scapania calcicola* var. *ligulifolia, Plagiochila asplenioides, L. heterocolpa*).

This species, though common in the Coniferous Forest region of southern and central Quebec, is distinctly rare in the region of the Tundra and in the ecotone region between Tundra and Coniferous Forest.

7. **Lophozia** (*Leiocolea*) **bantryensis** (Hook.) St.

Quebec: "On wet rocks beside stream, north of barracks, Fort Chimo Air Base," Ungava Bay, *MLP-48-50, July 17, 1948* (plants few and sterile, but typical, among *Saccobasis, Preissia, Bl. trichophyllum, L. floerkei*). New to Quebec.

The present collection consists of relatively few plants. A single male inflorescence was found, but no archegonia could be demonstrated beyond the androecium. The plants, therefore, are dioecious. The larger plants were 2·5-2·8 mm. wide and agreed closely with the description of *L. bantryensis*. The cells of the leaf-apices were mostly 35-38 μ, in the leaf-middle 35-38 × 38-48 μ (eliminating the smaller-celled and paroecious *L. gillmani*). As in *L. gillmani*, the underleaves were quite distinct, subulate-linear (occasionally with one or two teeth or cilia near the base). Except for the larger cells, the plants were quite similar to much material referred to *gillmani*, from around the Lake Superior area. Associated are other lime-tolerating species (*Saccobasis polita, L.* (*Orthocaulis*) *floerkei, Preissia quadrata, Blepharostoma trichophyllum*).

This Arctic-alpine species has been reported only four times from North America. Jensen (1906, p. 309) reports it from Hurry Inlet, on the east coast of Greenland. Austin reports the species on the basis of material collected by Wolf (1873), from Colorado, without definite locality. Unless this report can be verified, the species should not be accredited to the flora of the United States. The third report is from New Denver, in

British Columbia. Polunin (1947) reports it from the Arctic Islands lying north of the region here covered. The present report, therefore, is the first for the mainland of eastern North America.

8. **Lophozia** (*Leiocolea*) **muelleri** (Nees) Dumort.

QUEBEC: "Island near mouth of Seal River, Cape Jones, *Marr 675, September 4, 1939* (with *Tritomaria scitula, L. floerkei, Scapania*). New to Quebec.

NORTHWEST TERRITORIES: "Borders of fresh water pond near the Hudson's Bay Co. Post, Tukarak I., Belcher Islands," *Marr 665c, August 27, 1939* (sterile; among *R. pinguis, Jungermannia? oblongifolia, Blepharostoma arachnoideum* var. *brevirete*). New to Northwest Territories.

The plants of *Marr 665c* are sterile but cannot be referred elsewhere, because their size is somewhat larger than that of *L. badensis*; they have small but discrete underleaves; the leaves have the cells about 22-26 μ in the lobes, about 25-30 $\times$ 32-38 μ in the leaf-middle, and possess moderate, but scarcely bulging trigones. The small size of the plants at once eliminates *L. schultzii* and *bantryensis* (furthermore the leaves are flat to somewhat concave); the absence of gemmae and cell size eliminates *L. heterocolpa;* the smaller cells eliminate *gillmani.*

The plants are somewhat atypical in that the cell-walls as well as trigones are strongly brownish pigmented. Frye and Clark (1945, p. 380) use this character to separate *L. harpanthoides*, but without validity. The pigmentation of the cell-walls in *Leiocolea* is largely controlled by intensity of insolation, and exposed forms of both *muelleri* and *schultzii* may develop deeply golden brown pigmented cell-walls.

Marr 675 also includes only sterile plants. These have a smooth cuticle (unlike most forms of *muelleri*); however, the underleaves are distinct throughout; and the cells of the lobes are 20-27 μ, whereas those of the leaf-middle are 18-24 $\times$ 24-28 μ (rather small for *mülleri*); the cell-walls and trigones are brownish. It is possible that this collection represents a gemma-free form of *L. heterocolpa*. Such forms are well known for being nearly impossible to place.

9. **Lophozia** (*Leiocolea*) **heterocolpa** (Thed.) Howe

QUEBEC: Manitounuck Sound "Slaty dolomite talus, island between Boat Opening and Schooner Opening," *Marr 650a, August 14, 1939* (with *Sc. degenii, Sc. cuspiduligera* (Nees) K.M., *Tritomaria quinquedentata* (Huds.) Buch); same data, *Marr 650b* (with *Tritomaria quinquedentata* (Huds.) Buch and *Scapania degenii* Schiffn.); same data, *Marr 650* (with *Scapania cuspiduligera* (Nees) K.M., *Sc. degenii* Schiffn., *Tritomaria quinquedentata* (Huds.) Buch and *Lophocolea minor* Nees. Richmond Gulf "crevice in wet sedimentaries, Fishing Lake Creek," *Marr 644, August 1, 1939* (with *Scapania cuspiduligera* (Nees) K.M., and *Preissia quadrata*). "Near Fishing Lake Creek, Richmond Gulf," *Marr 645, August 3, 1939* (with *Sc. cuspiduligera, Lophozia heterocolpa*). "Island near mouth of Seal River," Cape Jones, *Marr 676, September 3, 1939* (among *A. juratzkana Tr. scitula, Sc. curta, Bl. trichophyllum, L. floerkei, L. hatcheri, C. pleniceps*).

NORTHWEST TERRITORIES: "Near the Hudson's Bay Co. Post, Tukarak Island," Belcher Islands, *Marr 667, August 27, 1939* (among

Scapania ligulifolia, Plagiochila asplenioides, L. barbata); same data, *Marr 667a* (among *Saccobasis polita, Blepharostoma, L.* ? *quadriloba, Cephalozia pleniceps, Cephaloziella arctica* var. *alpina*). "Muck on diabase trap, near Hudson's Bay Co. Post, Tukarak Island," *Marr 664, August 27, 1939* (among *L.* (*O.*) *floerkei* var. *densifolia* Nees, *O. macounii, Tr. scitula, Pl. asplenioides*, etc.).

9a. **Lophozia** (*Massula*) **obtusa** (Lindb.) Evs.

QUEBEC: Cairn Island, Richmond Gulf, June 29, 1939, *Marr 306e*, fide Wynne & Steere, 1943; not seen by the writer.

This rather rare species reported to the north by Bryhn (1906, p. 32) from Ellesmere Island and by Jennings (1936, p. 14) from Southampton Island.

10. **Lophozia** (*Massula*) **grandiretis** (Lindb.) Schiffn.

QUEBEC: "On margin of pool on raised sand beaches on south side of mouth of Great Whale River, *Marr 661a, August 21, 1939* (with *Geocalyx graveolans, Mylia anomala, Cephalozia leucantha*, etc.); same data, *Marr 661g*, over peat (with *Cephaloziella elachista* (Jack) Schiffn. *Mylia anomala, Cephalozia leucantha, Lophozia wenzelii*). (New to Quebec; in North America previously reported only from Minnesota and Vermont.)

The present plants came from among mosses and *Cephalozia leucantha, Mylia anomala, Geocalyx graveolans*, etc. Only a few plants were found, but the species is so extraordinarily distinctive that no difficulty was experienced in identifying it at first glance. The plants, as is normally the case with exposed plants of the species, had deep, wine-red stems (with the dorsal as well as ventral surface pigmented) and had hyaline leaves with large cells (40-50 × 60 μ or larger in the basal half of the leaf), with extremely thin cell-walls; a few of the peculiar oil-bodies recently described by the writer (Schuster, 1949) could still be identified. The leaves were flaccid and undulate, bilobed by an obtuse sinus. In addition, the large, peculiar, sharply stellate, pale green gemmae were found. The plants occur here associated with the same groups of species (*Geocalyx, Mylia anomala, Cephalozia* sp.) as on peaty banks in the northeastern tip of Minnesota (Belle Rose Island, Cook County). The plants from the two localities were compared and are, in effect, identical.

11. **Lophozia** (*Isopaches*) **bicrenata** (Schmid.) Buch

QUEBEC: "Margin of pool in granite near mouth, Great Whale River," *Marr 660c, August 7, 1939* (among *Sphenolobus minutus, Temnoma setiforme, Calypogeia trichomanis, Ptilidium ciliare, Cephaloziella arctica*?). (Apparently the northernmost station in eastern North America for this species. Lepage (1945) reports it only from southern Quebec: Rivière à Martre; Salmon River; Spider River; Tadoussac.)

Though very few plants were present, a single perianth was found, showing the dentate male bracts below the perichaetial bracts and the ciliate-dentate perianth-mouth. The rounded, thick-walled leaf and perianth cells were well developed, and stellate, reddish brown gemmae were present (with the leaves of gemmiparous characteristically dentate). The determination of the species, therefore, is quite definite.

12. **Lophozia** (*Dilophozia*) **alpestris** (Schleich.) Evs.

QUEBEC: "Arkose hillside near The Narrows, Cairn Island, Richmond Gulf," *Marr 633, June 29, 1939* (with gemmae; among *L. barbata* and *Ptilidium ciliare*). "Crevices in wet granite near the mouth of Great Whale River," *Marr 657, August 17, 1939* (with *Cephalozia ambigua, Anthelia julacea, Scapania paludicola, Preissia quadrata*). "Margin of pool in granite near mouth of Great Whale River," *Marr 660d, August 17, 1939* (with *Odontoschisma elongatum, Gymnocolea inflata*).

Also reported for Wakeham Bay and Great Whale River by Wynne and Steere (1943). Lepage (1945) cites it southward from Rupert River, from Lake Mistassini, and from several localities in southern Quebec.

13. **Lophozia** (*Dilophozia*) **longidens** (Lindb.) Macoun

QUEBEC: "Moist shady locality on arkose hillside near The Narrows, Cairn Island, Richmond Gulf," *Marr 631, June 29, 1939* (with *Temnoma setiforme, Lophozia ventricosa, Sphenolobus minutus, Ptilidium ciliare,* over lichens). "Granite rock near the mouth of Great Whale River," *Marr 653, August 17, 1939* (with *Temnoma setiforme, Lophozia ventricosa, Cephaloziella* ? *rubella*). Reported from Quebec from only one locality, to the south, Tadoussac (*See* Lepage, 1945); the species here appears to reach the northern periphery of its range.

The plants of *Marr 631* were few, but typically developed, with the mature gemmae reddish brown. The plants evidently were from a more xeric site than the label indicated, since they occurred among lichens and with *Sphenolobus minutus, Lophozia ventricosa, Temnoma setiforme,* and a little *Ptilidium ciliare.*

14. **Lophozia** (*Dilophozia*) **ventricosa** (Dicks.) Dumort.

QUEBEC: "Moist shady locality on arkose hillside near The Narrows, Cairn Island, Richmond Gulf," *Marr 631, June 29, 1939* (among *Lophozia longidens, Sphenolobus minutus, Ptilidium ciliare, Temnoma setiforme,* over lichens). "Granite rock near the mouth of Great Whale River," *Marr 653, August 17, 1939* (among *Lophozia longidens, Temnoma setiforme, Cephaloziella* ? *rubella*); same data, *Marr 662, August 22, 1939* (with *L. atlantica, Mylia taylori*); same data, *Marr 662b* (with *L. kunzeana, L. ventricosa, Mylia taylori, Ptilidium ciliare, Cephalozia bicuspidata*). "Shaded moist granite near the mouth of Great Whale River," *Marr 662a, August 22, 1939* (among *L.* (*O.*) *atlantica* (Kaal.) K.M., *Mylia taylori* (Hook.) Gray); same data, *Marr 662* (with *Ptilidium ciliare, L. quadriloba, L. kunzeana, L. atlantica* (?), *Cephalozia bicuspidata, Mylia taylori* (Hook.) Gray). "Crevices of moist granite, near the mouth of Great Whale River," *Marr 656d, August 17, 1939.* "On moist sandy soil, stream N. of barracks area, Ft. Chimo Air Base," Ungava Bay, *MLP-48-46, June 17, 1949* (with *L. hatcheri, C. rubella*). "Dry river terrace, 80 miles up Leaf River," Ungava Bay, *MLP-49-96, August 15, 1948* (with *L. wenzelii, A. minutus, Pt. ciliare*); same data, *MLP-48-95, August 15, 1948* (with *L. atlantica, Cephaloziella* sp.). "Moist forest floor, Runway Bog, Fort Chimo Air Base," Ungava Bay, *MLP-48-19, July 8, 1948* (a few scattered plants, approaching *L. wenzelii*, among *Pleuroclada albescens* var. *islandica, Bl. trichophyllum, L. kunzeana, Sc. irrigua*).

15. **Lophozia** *(Dilophozia)* **wenzelii** (Nees) Steph.

QUEBEC: "On margin of pool on raised sand beaches on south side of Great Whale River, near mouth," *Marr 661d, August 21, 1939* (with *Cephalozia leucantha, Mylia anomala, Scapania irrigua,* over *Sphagnum*); same data, *Marr 661* (with *Lophozia kunzeana, Cephalozia loitlesbergeri, C. pleniceps, Mylia anomala, Calypogeia muelleriana, Riccardia pinguis, Cephalozia leucantha*); same data, *Marr 661g* (with *Cephaloziella elachista, Mylia anomala, Cephalozia leucantha,* and *L. grandiretis*). "Granite, near the mouth of Great Whale River," *Marr 655, August 17, 1939* (material a little doubtful; among *Mylia taylori, Ptilidium ciliare, L. atlantica, L. kunzeana*); same data, *Marr 655b* (with *C. ambigua, L. atlantica, Sph. minutus*). "Margin of pool in granite near the mouth of Great Whale River, *Marr 659, August 17, 1939* (with *Cephalozia bicuspidata, Mylia taylori, Ptilidium ciliare, Temnoma setiforme, Gymnocolea inflata*). "Borders of small pond on north side of Leaf Bay near the Narrows," Ungava Bay, *MLP-48-76, July 27, 1948* (with *A.* (*Sph.*) *minutus*). "Dry river terrace about 80 miles up Leaf River," Ungava Bay, *MLP-49-96, August 15, 1948* (with *L. ventricosa, A.* (*Sph.*) *minutus, P. ciliare*). (Not previously reported from Quebec.)

Most of the above collections are typical: representing pale green plants with concave leaves and an extremely shallow, lunate sinus, and with more or less purplish postical sides of the stem. Others have the leaves somewhat pigmented and approach closer to "*confertifolia*" Schiffn. Buch (1933) has included the latter among the synonyms of *wenzelii*, but at least some forms of *confertifolia* approach closer to *ventricosa* in the more angular, deeper sinuses of the leaves, and in the fact that the leaves are widest slightly below the middle (rather than slightly above the middle).

16. **Gymnocolea inflata** (Huds.) Dumort.

QUEBEC: "Submerged in running water near middle of Cairn Island, Richmond Gulf," *Marr 634, June 30, 1939* (a few scattered stems, among *Pellia epiphylla*). "Margin of pool in granite near mouth of Great Whale River," *Marr 660a, August 17, 1939*; same data, *Marr 660d* (with *Odontoschisma elongatum, Lophozia alpestris*); same data, *Marr 659* (with *Cephalozia bicuspidata* (*L.*) Dum., *Mylia taylori, Ptilidium ciliare, Temnoma setiforme, Lophozia wenzelii*).

17. **Saccobasis polita** (Nees) Buch

QUEBEC: "On wet rocks beside stream, Ft. Chimo Air Base," Ungava Bay, *MLP-48-50, July 17, 1948* (with *Preissia, L. bantryensis, Bl. trichophyllum, L. floerkei*). "On contact between sedimentaries and the overlying diabase trap, hills of mainland south of Cairn Island," Richmond Gulf, *Marr 646, August 9, 1939* (occurring among *Preissia quadrata,* together with *Anthelia julacea, Jungermannia oblongifolia, Blepharostoma trichophyllum*).

NORTHWEST TERRITORIES: "Near Hudson's Bay Co. Post, Tukarak Island," Belcher Islands, *Marr 667a, August 27, 1939* (with *Lophozia heterocolpa, Blepharostoma, Cephalozia pleniceps, Cephaloziella arctica* var. *alpina*). Also collected on Tukarak Island by Douett (1938) fide Wynne and Steere (1943).

This essentially Arctic-alpine species is reported also from the Gaspé Peninsula (Lepage, 1945), the sole previous report from Quebec. Polunin (1947) also cites the report of the species from the Hayes Sound region on Ellesmere Island (Bryhn, 1906, p. 40). Judging from the accompanying species, *S. polita* is one of a large group of pioneer or near-pioneer species that undergoes ecesis on basic rocks or thin soil over basic rocks.

The present collections are of interest in that the cortical stem cells have the lumen three to eight times as wide as the walls and in that the lower part of the medulla is abundantly mycorrhizal—many individual cells being deep brown. The relatively little thick-walled cortical cells are almost as in European material I have studied, collected by Loitlesberger. This indicates conclusively that the use of the thickness of the cortical cell-walls as a generic character (as in Frye and Clark, 1945) is not warranted. All collections I have seen of this species agree in that the cortical cells never have the walls more than half as thick as the lumen. The material figured by Buch (1933) must be, therefore, an extreme pachydermous modification, and it is unfortunate that his illustrations were used as a basis for generalization by Frye and Clark.

18. **Anastrophyllum** (*Sphenolobus*) **minutus** (Cr.) Schuster

QUEBEC: "Moist shady locality on arkose hillside near The Narrows, Cairn Island, Richmond Gulf," *Marr 631, June 29, 1939* (over lichens and with *Temnoma setiforme, Lophozia longidens, L. ventricosa, Ptilidium ciliare*). "Margin of pool in granite near mouth of Great Whale River," *Marr 660c, August 17, 1939* (with *Calypogeia trichomanis, Temnoma setiforme, Ptilidium ciliare, Cephaloziella arctica*?, *Lophozia bicrenata*). "Granite near mouth of Great Whale River," *Marr 655b* (among *C. ambigua, L. wenzelii, L. atlantica, M. taylori*). "Borders of small pond on north side of Leaf Bay near the Narrows," Ungava Bay, *MLP-48-76,* July 27, 1948 (mod. *megafolia-densifolia,* near the var. *grandis*; with *L. wenzelii*). "Moist pocket under rock ledge on dry river terrace, about 80 miles up Leaf River," Ungava Bay, *MLP-48-84, August 13, 1948* (scattered stems among *Pt. ciliare*). "Dry river terrace about 80 miles up Leaf River," *Ungava Bay, MLP-49-96, August 15, 1948* (with *L. wenzelii, L. ventricosa, Pt. ciliare*).

Also reported from Wakeham Bay, Port Harrison, Great Whale River, and Cairn Island by Wynne and Steere (1943) and Lepage (1945); the latter also cites it from Rupert River and many stations in southern Quebec. Polunin (1947) compiles the numerous reports of the species from the Arctic regions.

19. **Temnoma setiforme** (Ehrh.) Howe

QUEBEC: "Moist shady locality on arkose hillside near The Narrows, Cairn Island," Richmond Gulf, *Marr 631, June 29, 1939* (over lichens, and among *Lophozia longidens, L. ventricosa, Sphenolobus minutus, Ptilidium ciliare*). "Granite rock near the mouth of Great Whale River," *Marr 653, August 17, 1939* (with *Lophozia longidens, L. ventricosa, Cephaloziella*? *rubella*). "Margin of pool in granite near mouth of Great Whale River," *Marr 660, 660c, August 17, 1939* (*Marr 660c* with *Sphenolobus minutus, Calypogeia trichomanis, Ptilidium ciliare, Cephaloziella*? *arctica, Lophozia bicrenata*); same data, *Marr 659, August 17, 1939* (with *Cephalozia bicus-*

pidata (L.) Dum., *Mylia taylori, Ptilidium ciliare, Temnoma setiforme, Lophozia wenzelii, Gymnocolea inflata*). (From Quebec known previously only from Mont Albert and Mont la Table, in the Gaspé; *see* Lepage, 1945.)

NORTHWEST TERRITORIES: "On arkose, Mussel Cove, Tukarak Island, Belcher Islands," *Marr 672, August 31, 1939.* (New to Northwest Territories.)

Polunin (1947, *sub Chandonanthus setiformis*) cites the species from numerous stations in the Canadian Eastern Arctic, and from a single station in Quebec (Wakeham Bay), as well as from Labrador (Hebron). Evidently common in the Tundra Zone and occasional in the ecotone between Tundra and Coniferous Forest.

20. **Tritomaria quinquedentata** (Huds.) Buch

QUEBEC: "Wet crevices of arkose hillside near mouth of Low's Creek, mainland south of Cairn Island, Richmond Gulf," *Marr 635, July 2, 1939* (only a single plant, among *Ptilidium ciliare*). "Manitounuck Sound, slaty dolomite talus, island between Boat Opening and Schooner Opening," *Marr 650a, August 14, 1939* (with *Sc. degenii, Sc. cuspiduligera, Lophozia heterocolpa* (Thed.) Howe); same data, *Marr 650b* (with *Scapania degenii* Schiffn. and *Lophozia heterocolpa* (Thed.) Howe); same data, *Marr 650* (with *Scapania cuspiduligera* (Nees) K.M., *Sc. degenii, Lophozia* (*Leiocolea*) *heterocolpa* (Thed.), *Tr. quinquedentata* (Huds.) Buch, and *Lophocolea minor* Nees). "Near the mouth of Fishing Lake Creek, Richmond Gulf," *Marr 643, August 1, 1939* (among *Pl. asplenioides, Bl. trichophyllum*; together with gemmae-free plants of *T. scitula*).

21. **Tritomaria scitula** (Tayl.) Joerg.

QUEBEC: "Island near mouth of Seal River, Cape Jones," *Marr 676, September 3, 1939* (among *Anthelia juratzkana, Sc. curta, Bl. trichophyllum, L. floerkei, L. hatcheri, L. heterocolpa, C. pleniceps*). "Near the mouth of Fishing Lake Creek, Richmond Gulf," *Marr 643, August 1, 1939* (plants gemmae-free, occurring with and scarcely separable from *T. quinquedentata;* also with *Pl. asplenioides, Bl. trichophyllum*). (New to Quebec; Lepage, 1945, states that the previous reports of the species from Quebec are incorrect.)

NORTHWEST TERRITORIES: "Belcher Islands, muck on diabase trap, near Hudson's Bay Co. Post, Tukarak Island," *Marr 664, 664a, August 27, 1939* (with *Lophozia* (*O.*) *floerkii* var. *densifolia* Nees, *O. macounii, L. heterocolpa, Pl. asplenioides*). (New to Northwest Territories.)

Not known from the region north of the above stations. As the species is essentially low Arctic-alpine, it should certainly be found in the area treated by Polunin (1947).

Family SCAPANIACEAE

22. **Diplophyllum albicans** (L.) Dumort.

QUEBEC: Fishing Lake Creek, Richmond Gulf (*See* Wynne and Steere, 1943; not present in the present collections).

23. Diplophyllum taxifolium (Wahlenb.) Dumort.

QUEBEC: Fishing Lake Creek, Richmond Gulf (*See* Wynne and Steere, 1943; Lepage, 1945, also reports it from Cargnan, Tadoussac, Bic, Rimouski River, and Rivière Sainte-Anne-des Monts; not present in the present collections).

24. Diplophyllum apiculatum (Evans) St.

QUEBEC: Mainland south of Cairn Island, Richmond Gulf (*See* Wynne and Steere, 1943; not present in the present collections).

The occurrence of this essentially Temperate Zone species so far north is remarkable; it is not reported from Quebec elsewhere, and not from farther north than Maine and central Minnesota.

25. Scapania curta (Mart.) Dumort.

QUEBEC: "Island near mouth of Seal River, Cape Jones," *Marr 676, September 3, 1939* (scattered plants, with perianths, among *Anthelia juratzkana, Tr. scitula, Bl. trichophyllum, L. floerkei, L. hatcheri, L. heterocolpa, C. pleniceps*).

This appears to be the first reliable report of the species from Quebec. The old reports of the species (before 1928) are completely untrustworthy and may refer to any of about six species. Lepage (1945) does not list it from Quebec.

Polunin (1947) cites the report by Harmsen and Seidenfaden (1932) of the species from Exeter Sound in central Baffin Island; this is the only other recent report from the general area. The reports of *S. curta* var. *rosacea* (Corda) Carr. from Ellesmere Island (Bryhn, 1906, p. 50) probably do not belong here and may refer to *S. scandica* (*See* Polunin, 1947, p. 510).

The single collection cited above is unquestionably *S. curta*. It not only plainly shows the distinct border of thick-walled marginal cells but also exhibits the shortly dentate perianth-mouth with teeth 1-3 cells long that Buch (1928) has correctly stressed as one of the diagnostic characters of the species. The short teeth of the perianth-mouth are stressed by Buch as separating the species from *mucronata* Buch. The latter normally has a laciniate perianth mouth, but I find that it occasionally has short, crowded teeth on some perianths, very much like those of *curta*; hence this character must be used with some caution. The present collection of *S. curta* also exhibits scattered marginal teeth (on many leaves, but not on all). This is another valuable characteristic that serves to separate the species from *mucronata*, in which the leaf-margins are uniformly entire.

26. Scapania cuspiduligera (Nees) K. Muell.

QUEBEC: Manitounuck Sound "Slaty dolomite talus, island between Boat Opening and Schooner Opening," *Marr 650a, August 14, 1939* (with *Sc. degenii* Schiffn., *Tritomaria quinquedentata* (Huds.) Buch, *L. heterocolpa* (Thed.) Howe); same data, *Marr 650* (with *Sc. degenii* Schiffn., *Lophozia* (*Leiocolea*) *heterocolpa* (Thed.), *Tr. quinquedentata* (Huds.) Buch, and *Lophocolea minor* Nees). "Crevice in wet sedimentaries, Fishing Lake Creek, Richmond Gulf," *Marr 644, August 1, 1939* (with *Preissia quadrata, Lophozia heterocolpa*). "Near Fishing Lake," *Marr 645, August 3, 1939* (with *Plagiochila asplenioides, Lophozia heterocolpa*).

27. Scapania irrigua (Nees) Dumort.

QUEBEC: "In a thin sheet of water running over surface of exposed arkose near The Narrows, Cairn Island, Richmond Gulf," *Marr 629, June 29, 1939* (a mod. *colorata-pachyderma*, with *Marsupella sparsifolia, Cephalozia bicuspidata*). "On margins of pool on raised sand beaches on south side of mouth of Great Whale River," *Marr 661d, August 21, 1939* (a few stems, among *Cephalozia leucantha, Lophozia wenzelii, Mylia anomala*, over *Sphagnum*). "Moist forest floor, Runway Bog, Ft. Chimo Air Base," Ungava Bay, *MLP-48-19, July 8, 1948* (a few scattered plants, with pale green 2-celled gemmae, among *Pleuroclada albescens* var. *islandica, Bl. trichophyllum, L. kunzeana, L. ventricosa*).

28. **Scapania calcicola** var. **ligulifolia** var. n.[1]

QUEBEC: "Wet grassy slope, north side of Leaf Bay, near the Narrows," Ungava Bay, *MLP-48-78, July 27, 1948* (only a single plant, with gemmae, quite typical, mounted on slide; with *Sc. degenii, P. ciliare*).

NORTHWEST TERRITORIES: "Near the Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 667b, August 27, 1939* (with *Plagiochila asplenioides, Lophozia heterocolpa, L. barbata, Cephaloziella alpina*). "Crevices in dry arkose near Hudson's Bay Co. Post, Tukarak Island," *Marr 666, August 27, 1939* (a few plants, among *Preissia quadrata, Plagiochila asplenioides*). "Muck on diabase trap near Hudson's Bay Co. Post, Tukarak Island," *Marr 664a* (a few plants among *Tr. scitula, O. macounii, Pl. asplenioides, L. heterocolpa, L. floerkei, Bl. trichophyllum*).

The present collection represents an extreme development of the isolated *S. calcicola*. The latter is known from the Alps, from the Black Forest (a typical specimen is before me from Baden: Kaiserstahl, leg. K. Müller), Czechoslovakia (a specimen approaching the var. *ligulifolia* in the entire leaf-margins is before me, Drevenik Mountain, 612 m., Podradie, Slovenia, leg. Jan. Smarda), north to Scandinavia. The species has previously not been found west of Iceland (*See* Hesselbo, 1918). The present records, therefore, extend the range of *S. calcicola* to a new western limital point and are the first for North America. The species should occur in the area north of here and on the Greenland coast.

Scapania calcicola is an isolated species that appears to stand midway between the subgenus *Kaalaasia* and the Sectio Curtae of *Euscapania*.[2]

In the 2-celled, reddish brown gemmae, the green colour of the plant, the entire leaf-margins, the relatively concave ventral lobes, the very large and relatively persistent oil-bodies, and in the entire facies the species

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[1] *Scapania calcicola* var. *ligulifolia* var. n. Lobi integris; gemmae ferrugineis; corpora oleifera magnis, 2-4; lobi ventralis obtusa vel rotundata; cellulae marginalis pachydermae.

[2] The species gives somewhat the impression of a small form of *S. aequiloba*: with some leaves with stiffly erect dorsal lobes (Plate III, figures 1, 6). The majority of lobes are appressed, however, the cuticle is virtually smooth, and the general size of the plant is much smaller; in addition, the gemmae are reddish brown (pale green in *aequiloba*). There is, therefore, no close relationship to the Sect. Aequilobae.

The other section with which the species may be confused is the Sect. Compactae. In this Sectio, the leaf-lobes are similarly rounded to obtuse, and the cuticle is almost smooth. In fact, *S. ligulifolia* looks somewhat like a reduced *S. kaurini* or *compacta*, with unusually small dorsal lobes. The species differs from the Sectio Compactae, however, in the margined leaves (in the Compactae the marginal cells are equally collenchymatous as the inner).

Both the Sectio Aequilobae and Compactae have larger dorsal lobes and are in general more robust plants. Yet the present species appears to stand somewhere between these sections, and the Sectio Curtae and the Subgenus *Kaalaasia*.

approaches *Sc.* (*Kaalaasia*) *gymnostomophila*.[1] It differs from *Sc.* (*Kaalaasia*) *gymnostomophila* in the much larger dorsal lobes of the leaves (1/2-2/3 the ventral in size), which are either suberect and stand away from the ventral lobes (Plate III, figures 1, 6) or lie very loosely over them (Plate IV, figures 4-6); in the occurrence of 2-4 large oil-bodies in the leaf-cells (Plate III, figure 2) (which, however, may persist 10 or more years in herbarium material); and in the equally thick-walled marginal cells of the leaves, forming a slight but discrete border (Plate III, figure 5).

In Buch's classification of the Sectio Curtae, *Sc. calcicola* var. *ligulifolia* would key out to the Subsectio Marginatae, since there is a slight but discrete border of equally thick-walled cells. The species differs at once from the two described species of the Marginatae (*Sc. curta* and *parvifolia*) in the reddish brown colour of the gemmae and in the long-persistent oil-bodies that occur only 2-4 per cell (Plate III, figure 2). (The oil-bodies are little larger than in *parvifolia*; but the dorsal lobes are more rectangular and more widely spreading than in *parvifolia*. The oil-bodies are much larger than in *curta*, and the leaf-shape is also considerably different.)[2]

In the Subsectio Immarginatae the species appears to have no close relatives. The species of that subsection may occasionally produce somewhat reddish gemmae in strong sunlight; but then the entire plant becomes brownish coloured. (The material of *ligulifolia* is entirely green, except for the contrasting red-brown gemmae.) On the basis of the large and few oil-bodies, the variety could be keyed to *calcicola*, *mucronata*, or *arnellii*. It differs at once from the first two in the red-brown gemmae colour, and from the last in the 2-celled nature of the gemmae. The oil-bodies are very similar in size and number (and the sometimes brownish colour) to those of typical *calcicola*; the variety differs at once from *calcicola* in the entire leaf-margins as well as in the gemmae colour, and in the obtuse to nearly rounded ventral lobes (which on non-gemmiparous shoots are terminated by a single cell) (Plate III, figure 5).

Without further knowledge of the perianth, the position of this species within the subgenera and sections of Buch is extremely doubtful. The plant in its general appearance, the entire leaf-margins, somewhat concave ventral lobes (Plate III, figures 1, 3, 6) that vary from subapiculate to rounded at the tip (Plate III, figure 5), and in the contrast between green plant and red-brown, 2-celled gemmae, suggests *Sc. gymnostomophila*.

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[1] The North American variety appears to have reddish brown gemmae under all conditions. In Europe it is reported as with yellow-green gemmae or with the greenish to pale brownish (Macvicar, 1926). The material I have examined from Czechoslovakia is gemmiparous; it has the oldest gemmae very pale brownish.

[2] Buch (1928) keys the species out in the Subsectio Immarginatae, of the Sectio Curtae. Reimers (1940) has already commented upon the fact that with *S. calcicola* the distinction between the Marginatae and Immarginatae breaks down completely. I can fully substantiate his observations, both on the basis of European specimens before me and on the basis of the American material reported above. The specimen from Czechoslovakia has the leaves with the marginal cells almost thin-walled: hence no discrete border developed. The material from Baden has the denticulate leaf-margins very obviously bordered by 1-2 rows of thick-walled cells (contrasted to the collenchymatous inner cells). In the entire-leaved American form before me, the leaf-margins are distinctly, if not strongly bordered, by thicker-walled marginal cells (Plate III, figure 5). *S. calcicola*, therefore, if placed in the Sectio Curtae at all, should have gone into the Subsectio Marginatae. Buch (l.c.) also stresses in his key the fact that in *calcicola* the dorsal lobes are swiftly narrowed at base, almost constricted, and at the point of constriction often bear 1-2 teeth. This character also is very slightly developed in all of the collections (European and American) before me. As is evident (Plate III, figures 1, 6; Plate IV, figures 4-6), many of the leaves of *S. calcicola* var. *ligulifolia* are somewhat narrowed and rounded to a narrow dorsal base. This is not uniformly true, and often so slightly indicated that it offers no sure means of separation from the other species of the Sectio Curtae; furthermore, I have not been able to locate teeth near the dorsal leaf-base, and these appear to be of sporadic, if not exceptional occurrence. The European material from Baden, like the material described and figured by Buch (1928) had distinctly denticulate leaf-margins and strongly apiculate leaf-lobes. The material from Czechoslovakia has the leaf-margins entire, as in the var. *ligulifolia*. The species is evidently extremely old and isolated, and probably divisible into several genotypically distinct forms, if not into species. The writer would suggest that it be placed in a section of its own (Sectio Calcicolae) because of its isolated, yet synthetic nature.

Like *Sc. gymnostomophila*, the species appears to be a calciphyte: the associated species (*Plagiochila asplenioides*, *Lophozia* (*Leiocolea*) *heterocolpa*) often occur with *Sc. gymnostomophila* in the Lake Superior region. Should the species have plicate perianths, it should certainly go into *Kaalaasia*, rather than *Euscapania*. The writer tentatively suggests that it is a possible link between these two subgenera. As in *S. gymnostomophila*, the ventral lobes are more or less concave, and tend to be dorsally secund; the plant therefore appears somewhat convex when viewed ventrally. None of the members of the Sectio Curtae possess this peculiarity.

29. **Scapania degenii** Schiffn.

Quebec: "Diabase trap island a few miles north of Cairn Island, Richmond Gulf," *Marr 642, July 30, 1939* (with *Cephaloziella starkei*); same data, *Marr 642ab* (with *Cephalozia lammersiana, Plagiochila asplenioides*). "Island between Boat Opening and Schooner Opening, Manitounuck Sound," *Marr 648, August 14, 1939* (with *Lophozia barbata* (Schmid.) and *Ptilidium ciliare* (L.) Nees). "Manitounuck Sound, *Marr 650a, August 14, 1939*, slaty dolomite talus, island between Boat Opening and Schooner Opening," (with *Sc. cuspiduligera* (Nees) K.M., *Tritomaria quinquedentata* (Huds.) Buch, *L. heterocolpa* (Thed.) Howe); same data, *Marr 650b* (with *Tritomaria quinquedentata* and *Lophozia heterocolpa* (Thed.) Howe); same data, *Marr 650* (with *Sc. cuspiduligera* (Nees) K.M., *Lophozia* (*Leiocolea*) *heterocolpa* (Thed.), *Tr. quinquedentata* (Huds.) Buch, *Lophocolea minor* Nees). "On sandy soil among grasses, mouth of Leaf River," Ungava Bay, *MLP-48-217, August 25, 1948* (a single mature and several juvenile plants, among *Riccardia pinguis*, with *Marsupella arctica*). "Wet, grassy slope, north side of Leaf Bay near the Narrows," Ungava Bay, *MLP-48-78, July 27, 1948* (lacking gemmae, but otherwise typical; with *P. ciliare* and a single plant of *Sc. calcicola* var. *ligulifolia*).

Northwest Territories: "Moist crevices in diabase trap near Haig Inlet, Flaherty Island, Belcher Islands," *Marr 669, August 30, 1939*.

New to North America. This extremely rare species has been known from a single station in the Alps (Type), from one in Scotland, and from two in Scandinavia (*See* Müller, 1944). In addition to the above stations, I have collected it a single time in Minnesota (Temperance River, Cook County; this report discussed in detail in another connection).

Sc. degenii, like the other members of the *irrigua* group (in which it is placed by Buch, 1928) has the broad leaf-lobes (Plate VI, figures 1-4), large size, and undecurrent ventral leaf insertion (Plate V, figure 1) of that group. Unlike the other members of the *irrigua* group, the cortex of the stem has become thicker and 2-4 cells thick (Plate VI, figure 8), as first pointed out by Müller, 1947. In this regard, it approaches the *nemorosa* group. This and other similarities (size of oil-body, 1-celled gemmae) have led Müller to reiterate (1944) his original (1912) disposition of the species in the group *Nemorosa*.

Sc. degenii is very closely related to *paludicola* and *hyperborea* and bears a similarity to these two species that will result in confusion except by the experienced worker. The rather strongly arched keel (Plate V, figure 1), the convex, rather reniform dorsal lobe (Plate VI, figures 1-3),

the bulging brownish trigones (Plate V, figures 8-10), blackish stems, and reddish brown gemmae masses make the species appear superficially indistinguishable from *hyperborea*. The similarity goes even further: the ventral lobes are identical in form and dimensions, and the leaf-insertion is identical (compare Plate VI, figures 1-4 and Plate VII, figures 2, 8, 9). Like *hyperborea*, the obtuse point of the dorsal lobe is directed clearly outward (Plate VI, figures 1-4); on the other hand, in the otherwise similar *paludicola* the point is directed towards the stem apex (Plate VIII, figures 1, 3-9). In the writer's opinion *degenii* is much more similar to *hyperborea* than to *paludicola*, though Buch keyed it out with the latter. The keel, though frequently strongly arched (Plate V, figure 1), is never as sharply and narrowly semicircularly arched as in *paludicola* (Plate VIII, figures 1, 3). As in *hyperborea*, it is often scarcely more arched than in *irrigua*. Indeed, the use (in keys) of the development of an arched keel in this group is deceptive.

From both *hyperborea* and *paludicola* the present species differs at once in the 1-celled gemmae (Plate V, figures 3-4); it also differs from the latter in the very large oil-bodies (Plate V, figure 10; Plate VI, figure 7); and in the largely 3-stratose cortex of the stem (Plate VI, figure 8). In the material available (now 9 years old), the oil-bodies are very well preserved in most cases and present in nearly all cells (except in occasional dead, decolorate marginal cells where chloroplasts also are gone). Indeed, in many of the older cells from which the chloroplasts have nearly or quite disappeared, the oil-bodies are still present (Plate V, figure 10; Plate VI, figure 7). In the marginal cells they become smaller in one or two peripheral rows (Plate VI, figure 5).

The plants of *Marr 650* are sterile, but several of them have numerous, well-developed, reddish brown gemmae. This collection is of decided interest in that it indicates there is intergradation between *degenii* and *hyperborea*. Although some five to six hundred gemmae were seen, all were 1-celled at maturity (i.e., at time of dehiscence), except for two, which were 2-celled (typical of *hyperborea*). The plants had large, yellowish trigones and an extremely delicately verrucose cuticle. In the material of *Marr 642* numerous gemmae-bearing plants were found, of which the gemmae on about eight plants were studied (*circa* 1200-1500 gemmae were seen). In all cases a few of the oldest gemmae were 2-celled, although the percentage of 2-celled mature gemmae ran at best from 0·1 to 1·0 per cent.

As is indicated below, the characters used by Buch to separate *hyperborea* and *degenii* are not valid. I have seen some thousands of individual plants of *hyperborea*, from nearly twenty different collections (made personally in northern Minnesota). In the material from more exposed sites the keel of the leaves becomes shorter (Plate VII, figure 9) and more strongly arched in *hyperborea*: approaching the condition typical for *paludicola*. In other words, *hyperborea* undergoes a similar reaction to intense insolation as does *paludicola* but needs a greater stimulus to produce equal effects. More "hygric" plants of *hyperborea*, which are green throughout, have the keel weakly arched and considerably longer; such plants seem almost identical with *irrigua*, except for the reddish brown gemmae. Furthermore, in the European material I have seen of *degenii* (Nedalen, Sweden, 1842, Thed.; courtesy of Dr. H. Buch), the keel is also

scarcely semicircularly arched. Müller (1944, p. 248) furthermore figures numerous leaves of the species, from various sites; in only his figure 4e does the keel approach a semicircularly arched condition.

With the demonstration that the leaf-keel in both *hyperborea* and *degenii* is virtually identical in form and apparently undergoes the same type of modification with increase in insolation, the separation by Buch (1928, p. 45) can no longer be maintained.

Müller (1944, p. 249) would exclude *Sc. degenii* from the Sectio Irriguae because of the oil-bodies, which are according to Müller "bei der Irriguae-Gruppe klein [sind] und nur einzeln in der Zelle liegen, bei den Arten der Nemorosae-Gruppe dagegen von erheblicher Grösse sind und fast den ganzen Zellraum ausfüllen." As I have been able to see in numerous collections of *Sc. hyperborea* from Cook County, Minnesota (of which five different collections were sent to K. Müller and were pronounced by him also to be *hyperborea*), the oil-bodies in that species are large, occur few per cell, are found in the leaf-middle usually 2-5 per cell, and are up to 7·8-9 μ in diameter. In material of *degenii* from the Belcher Islands they proved 5·8-9 μ and also occurred 2-5 per cell (Plate V, figure 10). There is, therefore, no difference of any sort between *Sc. degenii* and *hyperborea* as regards size and number of oil-bodies.

There are only three other characters left that are used by either Buch (1928) or Müller (1944), or both, to separate *Sc. hyperborea* from *degenii*. Both Buch and Müller stress the 1-celled gemmae of *degenii* vs. the 2-celled ones of *hyperborea*. Müller (1944) also stresses the fact that the cortex of the stem of *degenii* is 2-4 cells thick (Plate VI, figure 8), whereas it is 1-2 cells thick in *hyperborea* (Plate VII, figure 1). Finally, Müller stresses the fact that the perianth of *degenii* is entire at the mouth, but Buch describes it as remotely denticulate (like the leaf-margins).

The fact that occasional gemmae of *degenii* are 2-celled has been stressed above. Furthermore, in the material of *hyperborea* cited above I find that the mature gemmae are often largely 1-celled. In individual plants studied, the percentage of 2-celled mature gemmae varied from about 85 per cent to as low as 35 per cent. There is, therefore, no absolute difference between the two species in this regard.

Müller has stressed the thick cortex of *degenii*. In the material of that species from the Belcher Islands it was 2-3 and, locally, 4 cells thick (Plate VI, figure 8). In material of *hyperborea*, from Minnesota, it proves to be 2, locally 3, cells thick (Plate VII, figure 1). Such a difference is scarcely enough to warrant a distinct species or to place a species in another species-group. Furthermore, Müller (p. 248, figure 4m) figures the cortex of *degenii* as consisting only of 2-cell layers. If my Plate VII, figure 1 (cortex of *Sc. hyperborea*) is compared with the figure 4m of Müller's (*Sc. degenii*), no difference will be noted. It should be stressed that the development of the cortex is controlled, at least to some degree, by the amount of insolation and moisture available. (This is especially true in the *undulata-subalpina* complex, as has been stressed by Buch, 1928.)

It is therefore apparent that if *Sc. degenii* is to be maintained at all as a distinct species, characters other than those I have here discussed will have to be found to effect a separation. In my estimate, *Sc. degenii* should be reduced to the status of a variety; perhaps a more arctic-alpine derivative

of *hyperborea*. I therefore find I cannot follow Müller (1944) at all when he proposes to place *degenii* in the Sectio Nemorosae and retain *hyperborea* in Sectio Irriguae. The position of both in the Sectio Irriguae, as in Buch 1928, appears to be far more natural.

Finally, the perianth-mouth is stressed as entire by Müller but by Buch is described as "an der Mündung ähnlich gezähnt wie der Blattrand" (i.e., with distant, fine 1-2 celled teeth). Buch describes the perianth-mouth of *hyperborea* as "nur sehr wenige 1-3-zellige Zähne tragend." I therefore find that there is no consistent difference between *hyperborea* and *degenii* as regards the perianth-mouth.

I have collected material of *degenii* in Minnesota. (This had *circa* 99·95 per cent of the gemmae 1-celled; only a single 2-celled gemma could be found.) This material abundantly bore perianths, which varied widely in the nature of the mouth. Parts were subentire with occasional scattered small teeth (Plate VI, figure 9); other parts bore more numerous fine teeth. No difference, therefore, exists here between *degenii* and *hyperborea*.

The writer would seriously question the specific distinctness of *degenii*, and is tempted to reduce it to a variety of *hyperborea*. As is obvious from the above discussion, the characters separating it from *hyperborea* are either slight (form of gemmae) or non-existent. The *hyperborea-degenii* question is discussed in connection with a study of the Hepaticae of Minnesota (Schuster, 1951), in which the two are critically treated.

Judging from the accompanying species (that are either lime-tolerant or distinctly "calciphilous"), *Sc. degenii* is a calciphyte. The occurrence ("diabase trap," "slaty dolomite talus") also confirms this. In Minnesota the *degenii-hyperborea* complex is also distinctly "calciphilous," even if weakly so. Since even the ecological features of the type with 1-celled gemmae (*degenii*) and the type with 2-celled or partly 2-celled gemmae (*hyperborea*) appear to be similar or identical, we have even further confirmation that no separation on this basis is warranted.

30. **Scapania paludicola** Lske. et K. Müll. var. **viridigemma** var. nov.[1]

QUEBEC: "Crevices in wet granite near the mouth of Great Whale River," *Marr 657, August 17, 1939* (a little doubtful, most plants being impoverished and approaching *irrigua*, but one or two large and typical plants; with *Cephalozia ambigua, Anthelia julacea, Preissia quadrata, Lophozia alpestris*); same data, *Marr 656b* (with *Plectocolea subelliptica*).

The collection by *Marr 656b* is critical in several respects. Gemmae are present on the plants (Plate VIII, figure 2) and have colourless walls (hence are pale green). This indicates that neither *Sc. degenii, paludicola,* or *hyperborea* can be at hand, since these species supposedly produce brownish or reddish brown gemmae-walls even under conditions of relatively diffuse light. Buch (1928, p. 92) indicates that in his cultures *paludicola* had brownish gemmae even when the plants grew in relatively diffuse light and produced a mod. *parvifolia-viridis* in which the leaves had long, slightly arched keels, narrower leaves and more divergent dorsal lobes (i.e., closely approximated "normal" *irrigua*). It would therefore appear that the present plants cannot be typical *paludicola*, because of the greenish gemmae.

[1] *Scapania paludicola* var. *viridigemma* var. nova. Gemmae viridis, haud ferrugineis.

However, the habitus of the plants is exactly that of *paludicola* and, if the plants were gemmae-free, would have been referred to *paludicola* without any question (Plate VIII, figures 1, 3, 9). The dorsal lobes are cordate (Plate VIII, figures 1, 4), with the point directed towards the stem-apex (diverging at an angle of 0-15, rarely 20 degrees); the keels are strongly arched and often semicircular (Plate VIII, figure 3), varying from 0·3 to 0·16 the length of the ventral lobe; the ventral lobes are very broad and vary from 1·0 to 1·3 as wide as long (Plate VIII, figures 1, 3-4) and appear orbicular (except for the broadly triangularly pointed apex).

There are two possible explanations for these plants: (1) The gemmae colour is a variable character, perhaps controlled by one or few genes—hence not specific. (In this case the local plants would have to be referred to *paludicola*.)[1] (2) *Sc. irrigua* reacts almost exactly like *Sc. paludicola* and under extreme conditions (of light and transpiration) may produce *Sc. paludicola*-like modifications (i.e., with strongly arched keels, broader leaves, etc.). The first explanation seems more probable to the writer, because I have collected *irrigua* from strongly insulated sites, with strongly papillose cuticle and bulging trigones (Lake Superior Shore of Minnesota); such plants had elongate keels, relatively narrow ventral lobes. (The present plants have a nearly smooth cuticle and have very small trigones with concave sides and also show no brownish pigmentation, usually produced under insulated conditions.) I would therefore divide *paludicola* into two forms, typical *paludicola* with brownish gemmae under even diffuse light and the var. *viridigemma* with green gemmae under all conditions.

31. **Scapania parvifolia** Wstf.

QUEBEC: "Granite near the mouth of Great Whale River," *Marr 655c, August 17, 1939* (among *Cephalozia ambigua, Mylia taylori*).

This Old World species had not been hitherto reported from North America. Previously known from a few localities in Norway, Sweden, Finland, Scotland, Europe, and Siberia (*See* Buch, 1928). The present collection includes a limited number (twenty-five or more) typical plants, showing all of the characteristics of the species: thick-walled marginal cells 12-16 μ, occasionally ones 17-18 μ wide (15-22 μ in *curta*); reddish pigmentation of the entire plants; very short leaf-keel, about 0·35 per cent of the length of the ventral lobe(Plate I, figures 1-4); very strongly divergent dorsal and ventral lobes: the dorsal mostly diverging from the stem apex at a very acute angle, the ventral spreading widely; very narrow, lingulate ventral lobes, mostly 0·4-0·65 as wide as long (Plate I, figures 1-4; Plate II, figures 1-2). There cannot be any doubt about the identity of these plants, and the species as stressed by Buch (1928) appears to be clearly distinct from the most closely related species, *Sc. curta*.

Buch (1928) figures a leaf with sharply spinose-dentate margins. Similar leaves characterize gemmiparous plants of the present collection (Plate I, figures 1-4). The tendency for gemmae-bearing plants to develop such long, sharp marginal teeth appears to be a valuable characteristic,

[1] It should be noted that I have collected similar plants of *paludicola* with typical *paludicola* habitus and facies with green gemmae at a bog 8 miles southwest of Gheen, St. Louis County, Minnesota. Therefore, this form of *paludicola* with green gemmae appears to be widespread in North America. Müller (1944, p. 266) states that "in *S. paludicola* (the gemmae) in the juvenile state are also light green and become dark brown only at full maturity."

separating this species not only from *Sc. curta* but from the members of the Subsectio Immarginatae as well (except for *Sc. scandica*). Gemmae (Plate I, figures 4, 6) occur abundantly in the present collection and are thin-walled and pale greenish (i.e., with the walls colourless), in spite of the fact that the leaves and stems are strongly vineous red to red-brown pigmented, the plants representing a pronounced mod. *colorata-pachyderma*. The border of smaller, obviously, and strongly thick-walled marginal cells are very well developed in the present plants, and in most cases 2-3 or even more cells wide (Plate II, figures 3-4). Such a border is shared, in the Sectio Curtae, only with *Sc. curta*.

Among the Subsectio Immarginatae the species undoubtedly finds its nearest related species in *Sc. scandica*. It shares, with the latter, the development of reddish pigmentation in direct sunlight, the rather small marginal leaf-cells (which average a little larger in *Sc. scandica*), the entire perianth-mouth, the tendency to produce obtuse ventral lobes (Plate II, figure 4), as well as the characteristic tendency for the leaves on gemmiparous plants to develop sharp, spinose, scattered marginal teeth of both dorsal and ventral lobes, relatively small gemmae, and a rather short keel of the leaves (0·33-0·5 the length of the ventral lobe). Furthermore, the oil-bodies are relatively small in both species and occur 2-5 per cell in the leaf-lobes. The chief differences between the two species lie in the distinctly margined leaves of *parvifolia*, the somewhat smaller marginal cells (averaging only 14-15 μ wide), the somewhat shorter keel (0·33-0·40 the length of the ventral lobe), and the more divergent dorsal and ventral lobes (Plate I, figures 1-3); finally, the ventral lobes in *parvifolia* are somewhat narrower, ranging from 0·42-0·65 (fide Buch, 1928, p. 62), whereas in the material before me they vary from 0·57-0·68 as wide as long (in *Sc. scandica* 0·45-0·80, fide Buch).

The differences cited by Buch (1928) between the two species are not always as sharp as indicated. Although the marginal cells average 14-15 μ wide on most ventral lobes, they may average 17-18 μ near the apices of dorsal lobes (approaching *curta*); in the local material the gemmae (Plate I, figure 6) are considerably larger, ranging from 11 $\times$ 20 μ to 13 $\times$ 25 μ (i.e., fully as large as in *curta*). Furthermore, although the marginal cells are much smaller than those of *curta*, the median leaf-cells may be fully as large. According to Buch, *parvifolia* has the median leaf-cells 15-20 μ (in *curta* 15-22 μ). Buch also stresses the fact that *parvifolia* has narrower ventral lobes (45 to 65 per cent as wide as long) than *curta* (60 to 85 per cent as wide as long). This difference is not sharp, and on the local material the ventral lobes vary from 0·57-0·68 as wide as long, on most leaves (Plate I, figures 1-3; Plate II, figures 1-2). One of the most valuable characters in which the two species differ appears to be in the distinct difference in size between the marginal and median cells of *parvifolia* vs. the nearly equal size in *curta*.

In spite of the fact that *parvifolia* appears to approach *curta* in several regards and that the differences cited between the two by Buch are not quite as sharp, two good species appear to be at hand. The spinose-dentate leaf-lobes of gemmiparous plants of *parvifolia* appear to be diagnostic: I have never seen such spinose-dentate leaf-margins associated with gemma production in *Sc. curta*.

32. **Scapania subalpina** (Nees) Dumort.

QUEBEC: "Crevices in moist granite near the mouth of Great Whale River," *Marr 656, August 17, 1939* (with *Plectocolea subelliptica* (Ldb.) Evs.). "Near the mouth of Fishing Lake Creek, Richmond Gulf," *Marr 643, August 1, 1939.*

33. **Scapania undulata** (L.) Dumort.

QUEBEC: "Richmond Gulf, Cairn Island, East Coast of Hudson Bay, falls of small stream, arkose slope east of The Narrows," *Marr 637, July 3, 1939* (with *Marsupella sparsifolia* (Ldb.) Dumort.).

NORTHWEST TERRITORIES: Belcher Islands, *Marr 422g*; fide Wynne & Steere, 1943; not seen by writer.

Also reported (*See* Lepage, 1945) from Seal Lake and, to our south, from Rupert River and other stations in southern Quebec. Polunin (1947) cites the species from Wolstenholme, northern Quebec, and from Southern Baffin Island and Ellesmere Island.

Family JUNGERMANNIACEAE (s. str.)

34. **Plectocolea subelliptica** (Ldb.) Evs.

QUEBEC: "Crevices in moist granite, near the mouth of Great Whale River," *Marr 656, August 17, 1939* (with *Scapania subalpina* (Nees) Dumort.; same data, *Marr 656b* (among *Sc. paludicola*). Two small patches were found in the collection, appearing to have come from some distance from each other; the first, among *Sc. subalpina*, had a smooth cuticle and was sterile; the second, with rough cuticle, was fertile and occurred among *S. paludicola.*

The second collection (*Marr 656b*) (associated with *Sc. paludicola*) was of fertile plants. The few fertile shoots present showed clearly the saccate antheridial bracts below the perigonal bracts; the immature perianths were beaked at the mouth and crenulate and were fused with the bracts for at least half their length on one side. The fact that the rhizoids were brownish and the bracts all entire and the median leaf-cells mostly 20-24 × 35-45 μ, together with the small size of the plant (mostly about 8-12 mm. long), establishes the fertile plants definitely as *subelliptica.*

The sterile plants (*Marr 656*) with smooth cuticle are very similar and probably belong here but can conceivably belong to *Jungermannia tristis* Nees.

The plants cannot be placed elsewhere, for the following reasons:

(1) The leaves are ovate, widest a little above the base, but not cordate; there are small trigones (this eliminates *cordifolia*).

(2) The plants are 1-2 cm. long and about 1·5-1·8 mm. wide, with spreading, distant, nearly flat leaves (this eliminates *oblongifolia*, which has similarly large cells, somewhat similarly shaped leaves).

(3) The marginal leaf-cells about 18-20 μ, those of the leaf-middle elongate and 20-24 μ × 38-46 μ (cells much larger than other species of *Jungermannia*, except the two listed immediately preceding).

35. **Nardia geoscypha** (De Not.) Lindb.

QUEBEC: "On contact between sedimentaries and the overlying trap, hills of mainland south of Cairn Island," Richmond Gulf, *Marr 647, August 7, 1939.* New to Quebec.

The present collection consisted of scattered sterile plants and a very few fertile ones. On the fertile plants the perigynium was at an angle with the stem, and the retuse-emarginate bracts were evident; although the leaves below the perichaetial bracts did not have antheridia, they were perigonal bracts, judging from their strongly concave nature. The plants were brownish and mostly 5-8 mm. long.

This species has an extremely wide range, from the higher parts of the Appalachians in Georgia and North Carolina, north to Greenland; it recurs again in the west, from Alaska south to California. However, this represents the first report of the species from the median part of the continent.

The plants grew in admixture with *Lophozia alpestris, Pleuroclada albescens* var. *islandica, Mylia taylori,* and *Blepharostoma trichophyllum.*

36. **Jungermannia oblongifolia** K.M.

QUEBEC: Richmond Gulf "On contact between sedimentaries and the overlying diabase trap, hills of mainland south of Cairn Island," *Marr 646, August 9, 1939* (with *Anthelia julacea* (L.) Dum., *Saccobasis polita* (Nees) Buch, *Preissia quadrata* (Scop.) Nees, *Blepharostoma trichophyllum* (L.) Dum.

NORTHWEST TERRITORIES: "Borders of fresh water pond near the Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 665, August 27, 1939* (a little doubtful; scattered among *R. pinguis, Bl. arachnoideum* var. *brevirete, L. muelleri*).

The two collections of this rare Arctic-alpine species are both sparse and sterile. The material cannot be referred elsewhere because of the shape of the leaves, which are concave, widest somewhat above base but below middle, tapering to a narrowly rounded apex, and about 1·2-1·5 as long as wide; they are typically almost perfectly egg-shaped, or a little narrower, and are not cordate at base. (The local plants have the leaves exactly as figured in Müller, 1916.) The leaf-cells, furthermore, are relatively large: the marginal vary from 16-19 or even 20 μ wide; those of the leaf-middle are 18-21 μ wide $\times$ 27-38 μ long, and towards base become even larger; the cell-walls are brownish, but trigones are mostly rather small and not bulging; the cuticle is smooth. The plants are brownish black, decumbent, and mostly only 0·4-0·6 mm. wide and about 3-6 mm. long.

The plants at first were believed referable to the *pumilla-schiffneri* complex, to which they appear superficially similar (except for the erect or suberect, rather concave leaves) both in size and leaf-shape. However, the leaf-cells are considerably larger, especially along the margins. Furthermore, intercalary androecia could be demonstrated on two of the Quebec plants: eliminating the paroecious *pumilla-schiffneri* complex. The plants at first were thought possibly to be *J. pumilla* var. *rivularis*: which may have equally large leaf-cells; however, the local material came from rela-

tively exposed and mesic sites and represents an impoverished, rather than robust form. The dioecious nature further makes it impossible to dispose of the plants here.

The species has been reported from northern Europe and Asia, and from Greenland (Vahl, 1829): it has not been reported from the North American mainland.

Family MARSUPELLACEAE

37. **Marsupella sparsifolia** (Lindb.) Dumort.

QUEBEC: "In a thin sheet of water running over surface of exposed arkose near The Narrows, Cairn Island, Richmond Gulf," *Marr 629, June 29, 1939* (among *Scapania irrigua* and *Cephalozia bicuspidata*). "Richmond Gulf, East Coast of Hudson Bay, Cairn Island, falls of small stream, arkose slope east of The Narrows," *Marr 637a, July 3, 1939* (with *Scapania undulata* (L.) Dumort).

The material of *Marr 637a* was found closely associated and partly intermingled with *Scapania undulata* (a form approaching *dentata*, but with subentire leaves). The plants occurred either as small pure patches, or intermingled among the *Scapania*. The spreading to squarrose leaves were a golden brown distally, green at base, on exposed plants, and had a rather distinct shining appearance; as is typical for *sparsifolia* the leaves and male bracts were widest towards the base and had a narrow, but open, acute sinus extending about one third the leaf-length, with the lobes rather narrowly triangular and either obtuse or subacute. Mature perianths were found and beneath them the obviously concave male bracts; these, however, no longer contained antheridia. On younger plants, antheridia could be demonstrated, but these plants had not yet developed perianths. In none of the bracts could more than a single antheridium be found. The distant leaves, golden-brown pigmentation of the leaf-apices and distal parts of the female bracts, and the small size (mostly 8-15 mm. high) gave the plants a very distinctive facies.

Although reported from New Hampshire, Michigan, and Nova Scotia in the east (and Alberta and British Columbia in the west), this species is rare and known from a single or, at most, two stations in each of these areas; it had not been previously reported from Quebec but should occur considerably farther northward.

The material of the other collection was very deeply brown pigmented, the plants looking blackish brown and standing erect as isolated stems among a mat formed by *Cephalozia bicuspidata* (near *lammersiana*) and *Scapania irrigua*; the plants were from an obviously strongly insolated site, since the accompanying *Sc. irrigua* was a mod. *colorata-pachyderma* with deep, golden brown, bulging trigones. This material also abundantly bore perianths; on a shoot with well-developed antheridial bracts, each of which bore 1-3 antheridia, there were mature archegonia at the tip of a plant, conclusively indicating the paroecious nature of the plants.

38. **Marsupella arctica** (Bergr.) Bryhn et Kaal. (= *groenlandica* Jens.)

QUEBEC: "On sandy soil among grasses, mouth of Leaf River," Ungava Bay, *MLP-48-217, August 25, 1948* (a single, well-developed typical plant, among *Riccardia pinguis*, *Cephaloziella* sp., *Jungermannia* sp., *Scapania degenii*).

This represents the southernmost station for the species. It is otherwise known from Greenland and from Ellesmere Island (Bryhn, 1906, p. 27) and the European arctic regions (Spitsbergen). Recently Polunin (1947) reported it from South Baffin Island (Lake Harbour) and from the northern tip of Quebec (Wolstenholme). The latter was the first report of the species for the North American mainland.

39. **Marsupella emarginata** (Ehrh.) Dumort.

QUEBEC: Wolstenholme, in the northern tip of Quebec (north of the region here under discussion). Lepage (1945) also reports it from southern Quebec (Rivière à Martre, in the environs of Lac aux Sables; Waterloo). The species will certainly be found in our area.

Family PLAGIOCHILACEAE

40. **Plagiochila asplenioides** (L.) Dumort.

QUEBEC: "Diabase trap island a few miles north of Cairn Island, Richmond Gulf," *Marr 642ab, July 30, 1939* (among *Cephalozia lammersiana, Scapania degenii*). "Near Fishing Lake, Richmond Gulf," *Marr 645, August 3, 1939* (with *Sc. cuspiduligera, Lophozia heterocolpa*). "Near the mouth of Fishing Lake Creek, Richmond Gulf," *Marr 643, August 1, 1939* (with *T. quinquedentata, T. ? scitula, Bl. trichophyllum*).

NORTHWEST TERRITORIES: "Near the Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 667, August 27, 1939* (among *Scapania ligulifolia, Lophozia heterocolpa, L. barbata*). "Muck on diabase trap, near Hudson's Bay Co. Post, Tukarak Island," *Marr 664, August 27, 1939* (among *L.* (*O.*) *floerkei* var. *densifolia* Nees, *O. macounii, Tr. scitula, L. heterocolpa*).

All of the above material was checked to see if it could be referred to the putative Arctic polyploid derivative, *P. arctica*, but the leaf-cells averaged in all cases less than 35 μ in the leaf-middle. *P. arctica* was reported from Quebec by Frye and Clark (1946) and Lepage (1945), on the basis of a specimen from Islet Canuel, near Rimouski. Persson (1946) states that this material cannot be *arctica*, because of the smaller cell-size, and that Frye and Clark misunderstood that species. Judging from the figures and description in Frye and Clark, they figure one of the numerous reduced forms of *P. asplenioides* (and such were common among the material cited above). Such forms always have entire leaves that are relatively more oval (and not distinctly widest near the leaf-base) and are but little or not decurrent dorsally. Similar plants are common under exposed conditions in northern Minnesota. The writer would agree with Persson that such entire-leaved forms represent *P. asplenioides*.

41. **Mylia anomala** (Hook.) Gray

QUEBEC: "Moist shady locality above a temporary snowbank near The Narrows, Cairn Island, Richmond Gulf," *Marr 630, June 29, 1939* (a few plants, with smooth cuticle and a few typical *anomala* oil-bodies still preserved, among *Sphagnum, L. atlantica, C. trichomanis*). "On margin of pool on raised sand beached on south side of Great Whale River, near mouth," *Marr 661d, August 21, 1939* (with *Cephalozia leucantha, Scapania irrigua, Lophozia wenzelii*, over *Sphagnum*); same data, *Marr 661* (with *C. leucantha, C. loitlesbergeri, C. pleniceps, Lophozia wenzelii, L. kunzeana, Mylia anomala, Calypogeia muelleriana, Riccardia pinguis*); same data, *Marr 661a* (with *C. leucantha, Geocalyx graveolans, Lophozia grandiretis*). "Over peat on margin of pool on raised edges of sand beaches on south side of mouth of Great Whale River," *Marr 661g, August 21, 1939* (with *Cephaloziella elachista* (Jack) Schiffn., *Cephalozia leucantha, Lophozia wenzelii* and *grandiretis*).

Not reported from the Canadian Arctic north of 60° N. (*See* Polunin, 1947); the above, therefore, appear to represent the northernmost reports of the species in eastern North America. Lepage (1945) reports the species from Quebec, south of the region here considered (Rivière à Martre, above Lac aux Sables; La Tuque; Montmorency River; Saint Arsène, comté de Rivière-du-Loup; Mont Albert; Anticosti).

42. **Mylia taylori** (Hook.) Gray

QUEBEC: "Granite near the mouth of Great Whale River," *Marr 655, August 17, 1939* (a few plants, with gemmae, scattered among *Scapania parvifolia* and *Cephalozia ambigua*); *Marr 655a*, same data (with *L. atlantica, L. kunzeana, L. ? wenzelii, Ptilidium ciliare*); same data, *Marr 662, August 22, 1939* (with *L. atlantica, L. ventricosa*); same data, *Marr 662b* (with *L. kunzeana, L. ventricosa, Cephalozia bicuspidata, Ptilidium ciliare*); same data, *Marr 662a, August 22, 1939* (among *Lophozia* (*O.*) *atlantica, L. ventricosa*). "Manitounuck Sound, island between Boat Opening and Schooner Opening," *Marr 648a, August 14, 1949* (with *Lophozia* (*O.*) *atlantica*). "Crevices in moist granite, near the mouth of Great Whale R.", *Marr 656a, August 17, 1939* (with *Orthocaulis atlanticus, Lophozia* (?) *confertifolia, Pleuroclada albescens* var. *islandica*). "Margin of pool in granite near the mouth of Great Whale River," *Marr 659, August 17, 1939* (with *Cephalozia bicuspidata, Ptilidium ciliare, Temnoma setiforme, Lophozia wenzelii, Gymnocolea inflata*).

Not reported from the Canadian Eastern Arctic by Polunin (1947), although this essentially high subarctic-subalpine species must certainly occur there. Lepage (1945) reports it from Rupert River, above Lake Nemiskau, in the region immediately to our south; he also cites it from stations in southern Quebec: Sainte-Anne de la Pocatière; Mont Albert; Mont la Table; Rivière Sainte-Anne-des-Monts.

This species is generally found, unlike *M. anomala*, directly over acidic rock-walls, where it may be a pioneer or post-pioneer species. It occurs here associated most often with such species as *Lophozia* (*O.*) *atlantica*, (as at Great Whale River and Manitounuck Sound, Quebec), *Lophozia wenzelii*,

L. kunzeana, L. ventricosa, Ptilidium ciliare, Cephalozia bicuspidata, etc. Most frequently the species forms dense masses on moist shaded granite cliffs; apparently never over basic rocks.

The best characteristic that separates this species from *M. anomala,* is the roughened cuticle of this species. This is generally described as verrucose but actually appears fissured, being broken into numerous irregular, small elevated plates. No other hepatic in our region has the cuticle roughened in this peculiar fashion. The extremely large cells and subcircular to ovate-elongate leaves are shared with *M. anomala.* Unlike *M. anomala,* gemmae occur more infrequently, and on the margins of ovate leaves that are not tapered to a narrow point. The gemmiparous plants have the leaves (and often underleaves) somewhat irregularly dentate because of gemmae formation, but the leaves are not otherwise modified. When recently collected material is available, the oil-bodies offer a rapid method of distinction: in *taylori* they are large, mostly over 9-10 μ long, and consist of numerous minute spherules, forming an opaque, greyish ovoid body; they occur mostly 7-12 per cell and render the entire lumen opaque; they may persist up to 10 years or more in dry material. In *anomala,* on the other hand, they consist of a small number of large oil-globules, each individually protruding (thus belonging to the "Grape-cluster" type of Müller, 1939); they are in that way distinctly segmented.

Müller (1911, p. 782) characterizes *Mylia* as having the seta 7-8 cell-rows in diameter and with 18-20 epidermal rows of cells double the size of the interior cells and more thick-walled. This characterization appears drawn from *M. taylori,* and a part of the seta is figured by Müller, figure 343c, p. 782, with very large epidermal cells. I have studied sporophyte-bearing material collected by Marr at Great Whale River, August 17, 1939 (*Marr 656a*): here the epidermal rows of cells are merely about 56-60 μ and only 1-1·5 the diameter of the inner cells; furthermore, there may be up to 24 rows of epidermal cells, and the epidermal cells are scarcely thick-walled, except for the outer tangential wall. In another seta section I found up to 27 rows of epidermal cells, and the seta was 10-11 cells across; in this section there was virtually no difference apparent between the epidermal and inner cells, as regards size. In material I collected of *M. anomala* at a bog 2 miles north of Orr, St. Louis County, Minn., August 1947, the seta consisted of 24 epidermal rows, and the seta is 10-11 cell-rows across; furthermore, the epidermal rows average only 1·0-1·8 the size of the inner rows (72-76 μ vs. 56-75 μ in diameter). It is therefore apparent that the two species do not differ in the structure of the seta (which I believed to be the case when I knew only the seta of *anomala* and the figure by Müller of that of *taylori*), and that the seta-structure is more variable than admitted by Müller. The epidermal cell-rows, though always averaging slightly larger than the inner cell-rows (1·2-1·3 X usually) are only very rarely twice as large as the inner cells. The size of the epidermal cells of the seta, therefore, cannot serve as a distinction from *Haplozia* (= *Jungermannia*), although Müller (1911, p. 783) stresses that *Mylia* differs from *Haplozia* in the "very large epidermal cells."

Family LOPHOCOLEACEAE

43. Lophocolea minor Nees

QUEBEC: Manitounuck Sound "Slaty dolomite talus, island between Boat Opening and Schooner Opening," *Marr 650, August 14, 1939* (with *Scapania cuspiduligera* (Nees) K.M., *Sc. degenii* Schiffn., *Lophozia* (*Leiocolea*) *heterocolpa* (Thed.), and *Tr. quinquedentata* (Huds.) Buch); (also reported from Manitounuck Sound by Wynne and Steere, 1943; this apparently marks the northernmost point at which the species is found in North America).

The plants in this collection were very few, but quite typical, and bore gemmae.

Family HARPANTHACEAE (s. str.)

44. Geocalyx graveolans (Schrad.) Nees

QUEBEC: "On margin of pool on raised sand beaches on south side of Great Whale River, near mouth," *Marr 661b, August 21, 1939*; same data, *Marr 661a* (with *Lophozia grandiretis, Cephalozia leucantha, Mylia anomala*).

The first report of this essentially Temperate Zone species from northern Quebec. Certainly at or near its northernmost boundary here.

Family HYGROBIELLACEAE

45. Anthelia julacea (L.) Dum.

QUEBEC: "Crevices in wet granite near the mouth of Great Whale River," *Marr 657, August 17, 1939* (with *Cephalozia ambigua, Scapania paludicola, Preissia quadrata, Lophozia alpestris*) (material a little doubtful, but with typical pachydermous cell-net of *julacea*: sterile). "Richmond Gulf, on contact between sedimentaries and the overlying diabase trap, hills of mainland south of Cairn Island," *Marr 646, August 9, 1939* (with *Saccobasis polita* (Nees) Buch, *Preissia quadrata* (Scop.) Nees, *Jungermannia oblongifolia* K.M., *Blepharostoma trichophyllum* (L.) Dum.).

The above collections were all of sterile material. The plants had the typically incrassate leaf-cells of *julacea*. The species is known elsewhere from the region from Wakeham Bay, and from Cape Jones (*See* Lepage, 1944; Wynne and Steere, 1943).

46. Anthelia juratzkana (Limpr.) Trev.

QUEBEC: "Island near mouth of Seal River, Cape Jones," *Marr 676, September 3, 1939* (among *Tritomaria scitula, Sc. curta, Bl. trichophyllum, L. floerkei, L. hatcheri, L. heterocolpa, C. pleniceps*) (plants with rather thick-walled cells, but definitely paroecious). New to Quebec.

The separation of this species from *julacea* is often difficult, as has been commented on by various European students. The present plants must be referred here, because I was able to demonstrate a single paroecious inflorescence. Several capsules were found and had the spores up to 18 μ, as is typical for *juratzkana*. The leaf-cells were quite incrassate, almost as in *julacea*; this character appears to be environmentally controlled to a very large degree, hence, taxonomically, without very much significance.

47. **Pleuroclada albescens** var. **islandica** Nees .

Quebec: "Crevices in moist granite near the mouth of Great Whale River," *Marr 656a, August 17, 1939* (with *Mylia taylori* (Hook.) Gray, *Orthocaulis atlanticus* (Kaal.) Buch, *Lophozia? confertifolia* Schiffn.). "Moist forest floor, Runway Bog, Ft. Chimo Air Base, Ungava Bay," *MLP-48-19, July 8, 1948* (material abundant, with *Bl. trichophyllum L. kunzeana, L. ventricosa* near *wenzelii, Sc. irrigua*). "On contact between sedimentaries and the overlying diabase trap, hills of mainland, south of Cairn Island," Richmond Gulf, *Marr 647, August 9, 1939.*

Marr 647 is of typical material, scattered among *Lophozia alpestris, Nardia geoscypha,* and a little *Mylia taylori* and *Blepharostoma trichophyllum.* The plants, though not present in abundance, stand out from the reddish brown *Lophozia, Nardia,* and *Mylia* because of the whitish colour. The leaves in the present material are mostly divided $\frac{1}{3}$-$\frac{1}{2}$ and are little or not wider than long; the underleaves almost all lack any trace of lateral teeth. The plants, therefore, fall in the var. *islandica,* rather than in typical *albescens.*

The first collection (*Marr 656a*) consists of a single stem, found scattered in a mat consisting of *Mylia taylori, Lophozia* (*O.*) *atlantica,* and *Lophozia confertifolia* (?). Illustrations were drawn from this plant which was virtually identical with those from the second collection. The leaves were 1·0-1·1 as long as wide, divided $\frac{1}{3}$-$\frac{1}{2}$; the underleaves were ovate-lanceolate, lacking teeth; the leaf subtending a branch was undivided and exactly similar to an underleaf in form. The plant of this collection is preserved on a slide.

The species is high arctic. The variety has not been reported previously from the North American continent, though it occurs in Jan Mayen Island, Iceland, and westwards again in Greenland. Polunin (1947) cites the old report of the variety from Central Baffin Island ("West Side, rare," Taylor, ex Dickie, 1869, p. 465). Except for this report the variety has not been known west of Greenland.

Family Cephaloziellaceae

48. **Cephaloziella arctica** Bryhn et Douin ?

Quebec: "Margin of pool in granite near mouth, Great Whale River," *Marr 660c, August 17, 1939* (scattered sterile plants among *Sphenolobus minutus, Temnoma setiforme, Calypogeia trichomanis, Ptilidium ciliare, Lophozia bicrenata*). New to Quebec.

The material is fragmentary, and determination, therefore, must remain doubtful. The relatively few plants found, scattered among *Calypogeia trichomanis,* etc., were quite well developed, but sterile. Sterile plants showed small underleaves; the mature leaves had lobes 4-5, on large shoots 6 cells wide, and cells about 11-13 μ wide. The most important distinguishing feature lay in the extremely pachydermous cells of the leaves and stem-cortex, which were rounded and guttulate. The plants matched

closely the illustrations given by Jensen (1906) for his *C. verrucosa* (now considered a synonym of *arctica*), and I have had opportunity to compare the above plants with type material of *verrucosa* and find them indistinguishable.[1]

49. **Cephaloziella arctica** var. **alpina** (Douin) comb. nova.

Northwest Territories: "Near Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 667a, August 27, 1939* (among *Saccobasis polita, L. heterocolpa, L. quadriloba*?, *Blepharostoma, Cephalozia pleniceps*); same data, *Marr 667b* (among *Sc. ligulifolia, Plagiochila asplenioides, L. barbata*, etc.). "Moist crevices in diabase trap, near Haig Inlet, Flaherty I., Belcher Islands," *Marr 669a, August 30, 1939* (in same packet with *Sc. degenii*). New to Northwest Territories; apparently new to continental North America.

From the fragmentary material, it could be established that the plants were autoecious: male and female inflorescences occurring closely intermingled. The sterile plants had distinct, often large underleaves throughout. Leaves on well-developed plants had narrowly ovate lobes 5-7 cells broad, with the cells 11-12 μ wide and quite strongly thick-walled, but not guttulate; the male bracts were somewhat crenulate-denticulate on their margins; the female bracts were sharply dentate on their lobes. The plants key without difficulty to *alpina* in Douin (1920). Müller (1947) synonymizes *alpina* as a simple synonym of *arctica*, a procedure I am not willing to follow for the time being, because no intermediate specimens are before me. I have compared the above material with European specimens and find it to be quite similar. The material also agrees with Minnesota specimens collected by the writer (Grand Portage, Cook County), except that the cell-walls are more strongly thick-walled in the Belcher Island plants.

The second collection (*Marr 669a*) represents fertile material, in which the connection between the long antheridial spikes and perianth-bearing shoots was obvious: this material, however, had uniformly thin-walled cells. As in the above collection, the leaf-lobes were mostly 5-7, sometimes 9 cells broad at base, and underleaves occurred frequently on sterile parts of shoots (i.e., not near inflorescences). Except for the presence of underleaves and the slightly larger spores, this collection approaches *hampeana*.

Marr 669a consists of one or two small patches of plants, abundantly fertile, occurring with *Scapania degenii* (but not intermingled with it). The plants give the superficial appearance of either *C. byssacea* (*starkei*) or *hampeana*: e.g., have thin-walled cells and broad, ovate leaf-lobes, mostly 6-9 cells wide (or even more). As in *C. starkei*, there are distinct underleaves, which can be found on all but the most poorly developed and juvenile plants. Unlike *C. starkei*, but as in *hampeana*, the inflorescences are autoecious. Many partial plants were dissected out, some of which showed branches, each terminating in a male or female inflorescence: hence the plants were at first thought to be dioecious (and referable to *starkei*); however, several undoubted plants with male and female inflorescences on separate but connected branches were finally found, indicating such a disposition incorrect. The plants, therefore, have to be referred to the

[1] For the gift of a fragment of the type of *verrucosa* I am greatly indebted to Dr. Karl Müller, Baden, Germany.

arctica-alpina complex. Twelve spores measured showed five 9 μ in diameter, five 10 μ in diameter, and two 11 μ in diameter. The spores, therefore, agree with the size range for the *alpina-arctica* complex.

Though present in all recent lists of North American Hepaticae, there are no trustworthy reports from North America. The plant reported by Frye and Clark (1945) from Idaho as *C. alpina* cannot fall here, because they report it as dioecious.

50. **Cephaloziella elachista** (Jack) Schiffn. (mod. *pachyderma-colorata-verrucosa*)

QUEBEC: "Over peat on margin of pool on raised edges of sand beaches on south side of mouth of Great Whale River," *Marr 661g, August 21, 1939,* (with *Mylia anomala, Cephalozia leucantha, Lophozia wenzelii* and *grandiretis*). (New to Quebec; apparently the northernmost report for North America.)

Although only a few plants could be found of this species, the determination of the material can be considered definite. Unlike most material seen of *elachista,* the present plants had relatively thick-walled leaf and stem-cells, with the walls pale brownish or, on the exposed apices of shoots, purplish: in this characteristic the plants closely approach the related *C. subdentata.* The plants cannot belong to the latter for the following reasons: the stem-cells are 16-18 $\times$ 27-48 μ and smooth or only faintly striolate; the leaf-cells are smooth and 13-16 μ wide $\times$ 20-25 μ long; the leaves almost constantly show a spinose basal tooth on each side. Although plants with old androecia were found (showing dentate perigonal bracts), no perianths could be demonstrated. A single plant was found in which the autoecious inflorescence could be determined. On a few plants the cell-walls were extremely pachydermous, and such leaves had linear lobes 2-3 cells wide at base, 2·5-3·5 as long as wide, with the cells somewhat verrucose, and with no or few basal spinous teeth. Such plants closely approximated *C. subdentata* in form (especially the doubtful variety, var. *angustiloba* Douin); however, the leaf cells varied even on such exposed pachydermous plants from 13·5 to 16 μ wide $\times$ 18-38 μ long, indicating clearly that even when producing the rare modification *colorata-pachyderma-verrucosa, C. elachista* retains the relatively large cells characteristic of it.

The plants grew together in admixture with *Lophozia wenzelii, L. grandiretis, Mylia anomala, Cephalozia leucantha, C. loitlesbergeri, Calypogeia muelleriana,* and a little *Riccardia pinguis.* The few plants found are preserved on a slide.

51. **Cephaloziella hampeana** (Nees) Schiffn.?

QUEBEC: "Island between Boat opening and Schooner Opening, Manitounuck Sound, east coast of Hudson Bay," *Marr 648c.* (Reported from Quebec previously only from Tadoussac and Bic, in southern Quebec, fide Lepage, 1944.)

The present collection consisted of sterile plants, but the determination is almost certain. The stems showed no underleaves on non-gemmiparous shoots; the leaf-lobes were 6-8 cells broad and had thin-walled cells 11-13 μ wide. The plants were compared with fertile material from Minnesota, and the leaf-form and cells were identical.

52. **Cephaloziella rubella** (Nees) Warnstf. ?

QUEBEC: "Granite rock near the mouth of Great Whale River," *Marr 653, August 17, 1939* (among *Lophozia longidens, Temnoma setiforme, L. ventricosa*). "On moist sandy soil, stream north of barracks area, Fort Chimo Air Base," Ungava Bay, *MLP-48-46, July 17, 1948* (with *L. hatcheri, L. ventricosa*).

Here are referred two collections, on only one of which could paroecious inflorescences be determined. In both cases sterile shoots lacked underleaves, had leaves scarcely wider than the stem, and narrow leaf-lobes 4-5 cells wide, with incrassate cells 11-13 μ wide in most leaves.

The separation of the plants referred here from the var. *elegans* (or closely related species *elegans*) is to be accomplished only with difficulty. With study of numerous collections it becomes increasingly difficult to maintain any distinction between the various paroecious or paro-autoecious plants of the genus (*pulchella, elegans, sullivantii, rubella*). When Frye and Clark (1945) attempt, in addition, to maintain a species *myriantha* in this complex, they are scarcely simplifying the chaotic taxonomy of the complex. Mueller (1947) has reduced the species in the complex to two (*elegans, rubella*), and Persson (1946, p. 45) goes even further, recognizing only the single species *rubella*. After some months of painstaking and frustrating work on this complex (during which I have often found as many as three "species" of the complex in one patch of plants, probably all genotypically similar), I find myself thoroughly in sympathy with the treatment of the group by Persson.

53. **Cephaloziella rubella** var. **elegans** (Heeg) comb. nov.

QUEBEC: "Granite, near the mouth of Great Whale River," *Marr 655a, August 17, 1939.*

C. elegans (as delimited by Douin) is a difficult entity. Many plants belonging to the *rubella* complex are found with the cells of some leaves only 9-10 μ wide; others in the same collection have them 10-13 μ wide. The present plants fall in this category.

The present plants occurred sparsely, mixed among algae and lichens. They are referred here with a little doubt.[1] The plants belong to what was, for many years, called *C. myriantha*. Perigonal bracts occur below the perichaetial (i.e., the plants are paroecious), but occasional androecia occur that are intercalary on shoots that do not produce perianths. Although both male and female plants bear small underleaves, there are only isolated minute underleaves (2-5 cells) on sterile shoots. The leaves have ovate-triangular lobes, on well-developed sterile shoots 5 or 6 to 9 cells wide, with the individual cells averaging 10-13 μ broad, rather thick-walled.

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[1] The separation between *rubella* and *elegans* is virtually impossible to maintain, at least as carried through in Douin (1920). It is probable that *elegans* should be considered as a mere variety of *rubella*. Although the present collection approaches *rubella* in the relatively larger cells (11-13 μ wide on many leaves, with a minimum of 9-10 μ on other leaves) in the absence of underleaves on most sterile shoots, it agrees closely with *elegans* in the broader leaf-lobes, on robust sterile plants 6-9 cells broad at base. No plants could be found with the narrow leaf-lobes 4-5 cells broad, characteristic of *rubella*.

54. **Cephaloziella starkei** (Nees) Schiffn. (= *C. byssacea* (Roth) Warnstf.)

QUEBEC: "Diabase trap island a few miles north of Cairn Island, Richmond Gulf," *Marr 642, July 30, 1939* (scattered in a small patch, with *Scapania degenii*). (Reported previously from southern Quebec: Tadoussac, *see* Lepage, 1944.)

The plants of the present collection are antheridial and in a poor state of preservation, yet there can be no doubt about the identity of the material. The plants have leaf-lobes 5-7 cells wide, the cells about 11-13 μ wide, the walls rather thin and purplish pigmented. Although not present throughout, discrete and sometimes large, lanceolate to bifid underleaves occur on most sterile shoots; in their absence from some shoots the plants approach the var. "*subexamphigastria*" of Douin. Although antheridia were found, no trace of female inflorescences occurred, and the plants are certainly unisexual. Admixed were a few plants of *Scapania degenii*.

Family CEPHALOZIACEAE

55. **Cephalozia ambigua** Massal.

QUEBEC: "Crevices in wet granite near the mouth of Great Whale River," *Marr 657, August 17, 1939* (with *Anthelia julacea, Scapania paludicola, Preissia quadrata, Lophozia alpestris*). "Granite near the mouth of Great Whale River," *Marr 655, August 17, 1939* (with *Scapania parvifolia, Mylia taylori*). "Granite near mouth of Great Whale River," *Marr 655b, August 17, 1939* (with *Lophozia wenzelii, L. atlantica, Sph. minutus, Mylia taylori*). New to Quebec.

The present collections are of interest in that they mark the second published report for the eastern half of continental North America. It was reported by Sharp (1939) from Sevier County, Tennessee, near the summit of Mount Leconte. Bryhn (1906-1907) reported it from Breitstadfjorden, Ellesmereland, as *C. bicuspidata* var. *arctica* (now considered a synonym of *ambigua*). Persson (1946) reported it first from the western part of North America (Yakobi Island, on the east Pacific Coast, and King Cove, on the west coast). In addition, I have before me material from Mount Washington, N.H., collected in early July, 1944, *R. M.* and *O. M. Schuster*, which grew intermingled with *Lophozia* (*Orthocaulis*) *atlantica* and *gracilis*. The species thus appears to have an extensive range over arctic sections or islands in North America, extending southward to the crest of the Smoky Mountains (where it is certainly of disjunct occurrence).[1]

The species is often difficult to separate from *C. bicuspidata*, from which it differs chiefly in the much smaller size of the leaf cells and in having 9 instead of 18 chromosomes. The plants of *Marr 657* have the cells mostly quadrate and 19-20 μ wide, to a maximum of 24 μ wide and 20-25 μ long; on occasional leaves the lobes are more elongate, and the cells then may attain a length of 32-35 μ. Macvicar (1926) separates both *ambigua* and *bicuspidata* on the basis of the presence of stolons. In material received from Müller, from Germany, labelled as having 9 chromosomes and with the cell-net typical of *ambigua*, I could not find stolons. Neither could stolons be demonstrated in the material from Mount Washington, N.H.

[1] Polunin (1947) also cites a report of the species, from South Devon Island, by Jennings (1936).

In the present collection, however, stolons could be found abundantly, either originating as postical flagellae, or terminally from a normal, leafy shoot, whose apex suddenly became positively geotropic and leafless. It is therefore apparent that the presence or absence of stolons is not always a satisfactory character for separation. In the present plants the cell-walls are strongly and evenly thickened, and golden-brown pigmented.

Associated species were *Anthelia julacea*, *Preissia quadrata*, *Lophozia alpestris*, and a few plants referred to *Sc. paludicola*.

In the second collection (*Marr 655*) the plants were fertile and had perianths. The leaf-cells in these plants were somewhat larger, varying from 21-24 μ wide $\times$ 21-35 μ long. These plants were coloured a golden brown, like those of the first collection. Associated were *Scapania parvifolia* and a little *Mylia taylori*. The perianths of this collection had the mouth as is typical for *ambigua*: crenulate-denticulate, with the minute teeth never more than one cell long.

56. **Cephalozia bicuspidata** (L.) Dum.

Quebec: "In a thin sheet of water running over surface of exposed arkose near The Narrows, Cairn Island, Richmond Gulf," *Marr 629, June 29, 1939* (with *Marsupella sparsifolia*, *Scapania irrigua*). "Shaded moist granite near the mouth of Great Whale River," *Marr 662b, August 22, 1939* (among *Lophozia kunzeana*, *L. ventricosa*, *Mylia taylori*, *Ptilidium ciliare*, etc.). "Shaded moist granite near the mouth of Great Whale River," *Marr 662, August 22, 1939* (with *Mylia* and *L. ventricosa* and *L. atlantica*, *Ptilidium ciliare* (*L.*) Nees, *Lophozia floerkei* ?, *L. kunzeana*). "Margin of pool in granite near the mouth of Great Whale River," *Marr 659* (with *Mylia taylori*, *Ptilidium ciliare*, *Temnoma setiforme*, *Lophozia wenzelii*, *Gymnocolea inflata*).

The present collections are referred here (rather than to the very similar *lammersiana*) on the basis of presence of stolons, somewhat smaller average cell-size, and, in the case of the few fertile plants found, the presence of perianths on short postical shoots. Some of the sterile collections are somewhat doubtful.

57. **Cephalozia lammersiana** (Hueben.) Spruce

Quebec: "Diabase trap island a few miles north of Cairn Island, *Marr 642ab, July 30, 1939* (among *Scapania degenii*, *Plagiochila asplenioides*). New to Quebec.

The present collection is referred here, rather than to the very similar *bicuspidata*, because the perianths were on long leafy shoots, the female bracts had narrow, deeply divided bracts with entire lobes, flagellae were lacking (even below male and female inflorescences); the leaf-cells were quite elongate on most leaves (50-58 μ long). The collection is sparse and very poorly preserved.

58. **Cephalozia leucantha** Spruce

Quebec: "On margin of pool on raised sand beaches on south side of Great Whale River," *Marr 661d, August 21, 1939* (with *Scapania irrigua*, *Mylia anomala*, over *Sphagnum*; same data, *Marr 661a* (with *Geocalyx graveolans*, *Lophozia grandiretis*, *Mylia anomala*); same data, *Marr 661*

(with *Lophozia wenzelii, L. kunzeana, Cephalozia loitlesbergeri, C. pleniceps, Mylia anomala, Calypogeia muelleriana, Riccardia pinguis*). "Over peat on margin of pool on raised edges of sand beaches on south side of mouth of Great Whale River," *Marr 661g, August 21, 1939* (with *Cephaloziella elachista* (Jack) Schiffn. (mod. *pachyderma-colorata-verrucosa*), *Mylia anomala, Lophozia wenzelii* and *grandiretis*). Not listed from Quebec by Lepage (1944-45).

The material of this collection was very abundant, and both male and female plants were found.

The species has been reported a very few times from North America, with all but a few reports from the Pacific Coast. The writer recently detected the species in the eastern United States (Big Susie Island, Susie Islands, Cook County, Minnesota, *Schuster 1947*), but it appeared, until recently, to be unknown elsewhere in the region east of the Pacific Coast, except for a report from Cape Breton Island, Nova Scotia, and one from Bay of Islands, Newfoundland (*See* Evans, 1915). In the west, the species appears to be frequent, having been reported from Alaska (Columbia Fjord); Port Chatham; Douglas, Yukon (Hunker Creek); British Columbia (Port Renfrew, Vancouver Island; Ucluclet), southward as far as Washington (Westport; Aberdeen).[1]

59. **Cephalozia loitlesbergeri** Schiffner in K. Müller

QUEBEC: "Margin of pool in raised sand beaches on south side of mouth of Great Whale River," *Marr 661, August 21, 1939* (among *Cephalozia leucantha, C. pleniceps, Lophozia wenzelii, L. kunzeana, Mylia anomala Calypogeia muelleriana, Riccardia pinguis,* over *Sphagnum*). New to Quebec;[2] farthest north for the species in North America.

Only a few plants could be found, of which a single one was fertile (on slide); it showed all the characters of typical *loitlesbergeri*: monoecious inflorescence, female bracts laciniate-multifid, longly ciliate perianth mouth, cells 32-35 μ in most leaves (on others 35-38, occasionally 40 μ long),[3] cell-walls thickened, leaf-shape typical: with narrow, tapering, acuminate, strongly connivent lobes terminated mostly by a row of 3 cells (more rarely by 2 elongate cells).

60. **Cephalozia pleniceps** (Aust.) Lindb.

QUEBEC: "Margin of pool in raised sand beaches on south side of mouth of Great Whale River," *Marr 661, August 21, 1939* (among *Cephalozia leucantha, C. loitlesbergeri, Mylia anomala, Lophozia wenzelii, L. kunzeana, Calypogeia muelleriana, Riccardia pinguis*). "Island near mouth of Seal River, Cape Jones," *Marr 676, September 3, 1939* (among *A. juratzkana, Tr. scitula, Sc. curta, Bl. trichophyllum, L. floerkei, L. heterocolpa, L. hatcheri*).

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[1] Frye and Clark (1944, p. 498) also report it from several other localities from southern Quebec (Anticosti Island; Grand Rousseau; Sept Isles); they also cite an earlier report from Quebec. The writer (Schuster, 1951) first reports the species from the eastern half of the United States (Cook County, Minnesota).

[2] Since this was written the species has been reported from a single station in Quebec; *see* Fabius in Le Naturaliste Canadien (Août-Octobre) 1949.

[3] The cell-size to some degree varies with the length of the leaf: longer leaves having the cells up to 42, rarely 45 μ (then twice as long as wide, or nearly); in many leaves the cells are only 25-32 μ wide, with a maximum of 32-36 μ. On less elongate leaves the length in the leaf-middle may be only 28-32 μ.

NORTHWEST TERRITORIES: "Near Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 667a, August 27, 1939* (among *Saccobasis polita, Lophozia heterocolpa, L.? quadriloba, Cephaloziella arctica* var. *alpina*).

Marr 667a included only a few plants, but a 2- to 3-stratose perianth, crenulate perianth-mouth, obtusely bilobed female bracts, and autoecious inflorescence, as well as stolons, could be demonstrated; the leaf-cells were 35-38 μ, and leaves on robust shoots were up to 18 cells wide or more, with the somewhat obtuse lobes separated by a narrow, almost parallel-sided sinus. The other two collections were quite typical.

Family ODONTOCHISMACEAE

61. **Odontoschisma macounii** (Aust.) Underw.

QUEBEC: Wakeham Bay (Lepage, 1944); also reported (Lepage, 1945) from the central islands in Lake Mistassini, in the region south of that considered here.

NORTHWEST TERRITORIES: Belcher Islands "Muck on diabase trap, near Hudson's Bay Co. Post, Tukarak Island," *Marr 664* and *664a, August 27, 1939* (with *Lophozia* (*O.*) *floerkei* var. *densifolia* Nees, *Tr. scitula, L. heterocolpa, Pl. asplenioides, Sc. calcicola* var. *ligulifolia, Blepharostoma trichophyllum*, etc.).

62. **Odontoschisma elongatum** (Lindb.) Evs.

QUEBEC: "Margin of pool in granite near mouth of Great Whale River," *Marr 660d, August 17, 1939* (among *Gymnocolea inflata, Lophozia alpestris*). New to Quebec.[1]

The collection consisted of only a small quantity of plants, of which a single one showed the characteristic elliptical pale green 2-celled gemmae. The underleaves were relatively large and obvious, the cuticle smooth, and numerous postical branches and flagellae were observable. Although the plants represent a lax form with little concave, rather spreading, distant leaves, the characteristic brownish pigmentation was present. In many plants trigones were poorly developed, in a few moderately strongly bulging. The single gemmiparous plant showed gemmae at the apex of a virtually unmodified shoot, with scarcely reduced leaves.

Suborder PTILIDIINAE

Family PTILIDIACEAE (s. str.)

63. **Ptilidium ciliare** (L.) Nees

QUEBEC: "Crevices, arkose hillsides near The Narrows, Cairn Island, Richmond Gulf," *Marr 631, 632, 633, June 29, 1939* (*Marr 633* with *Lophozia barbata* and *L. alpestris*; *Marr 631* with *Lophozia longidens, Temnoma setiforme, Sphenolobus minutus*, among lichens). "Dry arkose

[1] Since this was written the species has been reported from Quebec. *See* Annales de l'ACFAS, 1949.

hillside east of The Narrows, Cairn Island, Richmond Gulf," *Marr 636, July 3, 1939* (with *Lophozia hatcheri, L. kunzeana*). "Wet crevices, arkose hillside near mouth of Low's Creek, mainland south of Cairn Island, Richmond Gulf," *Marr 635, July 2, 1939* (with *Tritomaria quinquedentata*). "Diabase trap island a few miles north of Cairn Island, Richmond Gulf," *Marr 642c, July 30, 1939*. "Granite, near the mouth of Great Whale River," *Marr 655, August 17, 1939* (with *L. atlantica, L. kunzeana, L.* ? *wenzelii, Mylia taylori*). "Margin of pool in granite near mouth, Great Whale River," *Marr 660, August 17, 1939* (among *Calypogeia trichomanis, Sphenolobus minutus, Temnoma setiforme, Ptilidium ciliare, Lophozia bicrenata*); same data, *Marr 659, August 17, 1939* (with *Cephalozia bicuspidata* (*L.*) Dum., *Mylia taylori, Temnoma setiforme, Lophozia wenzelii, Gymnocolea inflata*). "Shaded moist granite near the mouth of Great Whale River," *Marr 662, August 22, 1939,* (with *Mylia, L. ventricosa* and *L. atlantica, L. ventricosa* (Dicks.) Dum., *L. kunzeana,* and *Cephalozia bicuspidata*). "Island between Boat Opening and Schooner Opening, Manitounuck Sound," *Marr 648, August 14, 1939* (with *Scapania degenii, Lophozia barbata*). "Moist pocket under rock ledge on dry river terrace, about 80 miles up Leaf River," southwest of Ungava Bay, *MLP-48-84, August 13, 1948* (with *A. minutus*). "Dry river terrace about 80 miles up the Leaf River," Ungava Bay, *MLP-49-96, August 15, 1948* (among *L. wenzelii, L. ventricosa, A.* (*Sph.*) *minutus*); same data, *MLP-48-96a, August 15, 1948* (with *L. lycopodioides*). "On bark of creeping *Picea* and on soil, 1 mile north of Leaf River, about 80 miles up the river," Ungava Bay, *MLP-48-143, August 16, 1949*. "Wet grassy slope on north side of Leaf Bay near the Narrows," Ungava Bay, *MLP-48-78, July 27, 1948* (with *Sc. degenii, Sc. calcicola* var. *ligulifolia*).

Family BLEPHAROSTOMACEAE

64. Blepharostoma trichophyllum (L.) Dumort.

QUEBEC: "Richmond Gulf, on contact between sedimentaries and the overlying diabase trap, hills of mainland south of Cairn Island," *Marr 646, August 9, 1939* (with *Anthelia julacea* (*L.*) Dum., *Saccobasis polita, Preissia quadrata* (Scop.) Nees and *Jungermannia oblongifolia* K.M.). "Island in Mouth of Seal River, Cape Jones," *Marr 676, September 3, 1939* (among *Anthelia juratzkana, Tr. scitula, Sc. curta, L. floerkei, L. hatcheri, L. heterocolpa, C. pleniceps*). "Near the mouth of Fishing Lake Creek, Richmond Gulf," *Marr 643, August 1, 1939* (among *Pl. asplenioides, T. quinquedentata*). "On wet rocks beside stream, Fort Chimo Air Base," Ungava Bay, *MLP-48-50, July 17, 1948* (scattered plants among *Saccobasis polita, Preissia, L. bantryensis, L. floerkei*). "Moist forest floor, Runway Bog, Fort Chimo Air Base, Ungava Bay, *MLP-48-19, July 8, 1948* (traces among *Pleuroclada albescens* var. *islandica, L. kunzeana, L. ventricosa, Sc. irrigua*).

NORTHWEST TERRITORIES: "Near Hudson's Bay Co. Post, Tukarak I., Belcher Islands", *Marr 667* (scattered plants among *Saccobasis polita, L. heterocolpa, L. floerkei*?, *Cephalozia pleniceps*, etc.).

The collection from Tukarak Island is of interest in that it indicates that *trichophyllum* and *arachnoideum* var. *brevirete* may occur in the immediate vicinity, yet stay perfectly distinct. This appears to indicate that the latter cannot be a geographical variety (subspecies) of the former.

65. **Blepharostoma arachnoideum** var. **brevirete** (Bryhn et Kaal.) Frye & Clark

NORTHWEST TERRITORIES: "Borders of fresh water pond near the Hudson's Bay Co. Post, Tukarak I., Belcher Islands," *Marr 665, August 27, 1939* (sterile, a few plants, but typical; among *R. pinguis, Jungermannia oblongifolia, L. muelleri*). New for Northwest Territories.

Bryhn and Kaalaas described this as a variety under *B. trichophyllum*. Frye and Clark (1943, p. 194) have transferred it to *B. arachnoideum*, apparently quite correctly so. They question the distinction of *B. arachnoideum* as a species distinct from *trichophyllum*. In my experience the two are perfectly distinct, and the highly restricted distribution pattern of *arachnoideum* appears to confirm this. In both *arachnoideum* and *brevirete* the leaf-cells are very short, averaging little or no longer than broad, and the cells are somewhat constricted at the septa (rather than swollen, as is always the case in *trichophyllum*). The leaves, furthermore, are generally only of 3 (rather than 4) segments, whereas the underleaves often have 2, occasionally 3 segments (in *trichophyllum* nearly constantly 3-segmented).[1]

The leaves in the present collection consist mostly of 2-3 segments, with the cells 18-30 μ long and about 18-27 μ wide (i.e., 1-1·5 as long as wide).[2] The cells of the leaves and underleaves are very distinctly striolate-papillate (as in *trichophyllum*), and the stem is even more strongly striolate. The segments are quite distinctly constricted at the septa between the cells. In the many collections I have seen from Arctic regions of *B. trichophyllum*, I have never seen intergradation to the condition described above; the material reported above, however, closely approximates typical *arachnoideum* from Vancouver Island, B.C. It is questionable how distinct the two are. The variety has been reported a single time (Frye and Clark, 1943, p. 194), from the Cordilleras, except for the type locality in Ellesmereland.

Family LEPIDOZIACEAE

66. **Lepidozia reptans** (L.) Dumort.

QUEBEC: Manitounuck Sound (*See* Wynne and Steere, 1943; not among the present collections).

This marks the northernmost point in the range of the species in eastern America; westward known as far north as Alaska. In Quebec reported by Lepage (1945) from Lake Mistassini, and from numerous stations in southern Quebec.

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[1] Frye and Clark (l.c., figures 1, 4) figure "leaves" with 4-7, sometimes branched, divisions. These are certainly not leaves but probably perichaetial bracts (compare p. 194, figure 1 with p. 191, figure 5).

[2] The cells in the middle of the segments are mostly 18-22 × 18-24 μ; distally they attain 24-27 μ long; the basal cells are up to 24-27 μ wide

Family CALYPOGEIACEAE

67. **Calypogeia muelleriana** Schiffn.

QUEBEC: "On margin of pool on raised sand beaches on south side of mouth of Great Whale River," over *Sphagnum*, *Marr 661e*, *August 21, 1939* (among *Cephalozia leucantha*, *Mylia anomala*, *Lophozia wenzelii*, etc.); same data, *Marr 661* (among *Cephalozia leucantha*). New to Quebec.

This long neglected but apparently well-defined species has been reported from a number of stations in Europe (*See* Müller, 1947). The first report of the species from North America is from New York (Schuster, 1949). I have also seen other typical specimens from as far west as Vancouver Island, B.C. The species appears to have a scattered distribution throughout northern North America and will probably prove holarctic in range.

The present collection consists of somewhat impoverished plants, merely 1-2 mm. wide, growing over peat. Although very sparsely present in the collection (almost all plants found were mounted on two slides), the plants must be referred here, rather than to *trichomanis*[1] for the following reasons:

(1) The underleaves are 2-3 times as wide as the stem, shallowly emarginate and with rounded, broad lobes; their cells are large and vary from 25-32 μ wide $\times$ 45-55 μ long, or even to 60 μ long (in the underleaf-middle).

(2) The ovate lateral leaves have large cells, mostly 36-42 μ wide $\times$ 48-55 μ long in the leaf-middle, in some leaves averaging even 40 $\times$ 60 μ.

(3) The leaf-shape is of the typical *sphagnicola-muelleriana-trichomanis* type (i.e., on well-developed shoots, mature leaves are as wide to considerably wider than long, and on poorly developed shoots they become conspicuously long-decurrent).

68. **Calypogeia trichomanis** (L.) Corda

QUEBEC: "Moist shady locality above a temporary snowbank near the Narrows, Cairn Island, Richmond Gulf," *Marr 630, June 29, 1939* (among *Lophozia atlantica*, *Mylia anomala* over *Sphagnum*). "Margin of pool in granite near mouth, Great Whale River," *Marr 660c, August 17, 1939* (a few scattered but typical plants among *Sphenolobus minutus*, *Temnoma setiforme*, *Ptilidium ciliare*, *Cephaloziella*? *arctica*, *Lophozia bicrenata*).

The plants of *Marr 630* are placed here with a little doubt, since the facies of the plants is closer to that of *sphagnicola* and since the occurrence seems typical for *sphagnicola*; furthermore, the leaf-shape, general size, and form of underleaves are nearly identical with *sphagnicola*. The cell-size is, however, typical for the closely related *trichomanis*; in the leaf-apices the cells average 32-36 μ; in the leaf-middle they are 38-40 μ wide $\times$ 45-50 μ long, occasionally to 55-60 μ long; in the underleaves the cells are 35-38 μ $\times$ 40-50 μ long. On some plants the cell-size is even larger, and

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[1] Typical *C. trichomanis* also occurs locally (*See* next species) and is quite obviously different from the plants here referred to *muelleriana*.

the under-leaf cells may be 40 × 50-56 μ. The underleaves are deeply emarginate by a narrowly rounded sinus, and the lobes vary from acute to subacute. Judging from the cell-size and form of the underleaves, the plants are undoubtedly an impoverished form of *trichomanis*.[1]

Suborder Porellinae

Family radulaceae

69. **Radula complanata** (L.) Dumort.

Quebec: "Shaded crevices in arkose near Cairn Mountain, Cairn Island, Richmond Gulf," *Marr 638, July 8, 1939* (scattered plants among mosses; paroecious, with a few gemmae).

The present report appears to be the northernmost for the species. Polunin (1947) does not list it for the region to the north, and it scarcely can be expected to occur in the Tundra. It undoubtedly reaches its northern limital points in the ecotone area between Coniferous Forest and Tundra and is probably rare there. Lepage (1945) reports it from numerous stations in southern Quebec.

Order **Metzgeriales**

Family pelliaceae

70. **Pellia epiphylla** (L.) Cda.

Quebec: "Submerged in running water, Cairn Island, Richmond Gulf," *Marr 634, June 30, 1939* (paroecious; flap-like female involucres present; with *Gymnocolea inflata*). (Also reported from Great Whale River by Wynne and Steere (1943), and from Rupert River, below Lake Nemiskau, by Lepage (1945), as well as from other localities in southern Quebec.)

The species appears to reach its northernmost limits in the ecotone between Coniferous Forest and Tundra. It is unreported from the Arctic regions north of lat. 60°.

Family blasiaceae

71. **Blasia pusilla** L.

Quebec: "Wet sandy clay near the mouth of Great Whale River," *Marr 663, August 22, 1939.* "Sandy soil among grasses on river terrace, mouth of Leaf River," Ungava Bay, *MLP-48-210, August 22, 1948.*

The above two reports place the species at the ecotone area between the Tundra and Coniferous Forest, in an area very significantly north of previous stations known for it. It has been previously known only from southern Quebec (Gaspé Coast; near Hull; near Chelsea; Oka; Murray

[1] It is of interest that Lepage (1945) also reports *trichomanis* from a peat-bog, Moosonee, James Bay (Ontario). The species perhaps is more confined to such sites in the Far North, quite unlike its more frequent habitats further south. *Marr 660c* also is of small, somewhat impoverished plants approaching *sphagnicola* in size; the leaf-cells are 35-40 μ in the leaf-apices, and the underleaf cells are very large (eliminating *sphagnicola*).

River; La Tuque and Pont-Rouge; Buckingham; Lac Mégantic; Tadoussac; Lac Thibault, comté de Témiscouata); from Woodstock, New Brunswick; from Cape Breton Island; Prince Edward Island; from Algonquin Park, Parry Sound, and Thunder Bay, in Ontario. The species is essentially of temperate and boreal distribution, becoming rare in the upper edge of the "Canadian" zone.

Family ANEURACEAE

72. **Riccardia pinquis** (L.) Gray

QUEBEC: "On margin of pool in raised sand beaches on south side of mouth of Great Whale River," *Marr 661, August 21, 1939* (scattered among *Cephalozia leucantha, C. pleniceps, C. loitlesbergeri, Lophozia wenzelii, L. kunzeana, L. grandiretis, Geocalyx graveolans, Mylia anomala, Calypogeia muelleriana*). "On sandy soil among grasses, mouth of Leaf River," Ungava Bay, *MLP-48-217, August 25, 1948* (with *Marsupella arctica, Scapania degenii*). Also reported from Bill of Portland Island, Manitounuck Sound (Wynne and Steere, 1943).

NORTHWEST TERRITORIES: "Borders of fresh water pond near the Hudson's Bay Co. Post, Tukarak Island, Belcher Islands," *Marr 665, August 27, 1939* (scattered among *Leiocolea muelleri, Blepharostoma arachnoideum* var. *brevirete, Jungermannia oblongifolia*). New to Northwest Territories.

This species is surprisingly absent from many lists of plants from the Arctic Regions of Canada (*See* Polunin, 1947). Since it occurs on the Greenland coast, far north on both coasts, and has been reported from several localities in the Canadian Eastern Arctic (*See* Polunin, 1947), it appears to have a rather general distribution under Arctic conditions. Lepage cites the species from several stations farther south in Quebec.

Subclass *MARCHANTIAE*

Order **Marchantiales**

Family MARCHANTIACEAE

73. **Preissia quadrata** (Scop.) Nees

QUEBEC: "Crevices in wet granite near the mouth of Great Whale River," *Marr 657, August 17, 1939* (among *Cephalozia ambigua, Anthelia julacea, Scapania paludicola, Lophozia alpestris*). "Sandy soil of raised beaches near the mouth of Beach Creek, Richmond Gulf," *Marr 639, July 15, 1939* (with *carpocephala*). "Richmond Gulf, crevice in wet sedimentaries Fishing Lake Creek," *Marr 644, August 1, 1939* (with *Scapania cuspiduligera* and *Lophozia heterocolpa*). "Richmond Gulf, on contact between sedimentaries and the overlying diabase trap, hills of mainland south of Cairn Island," *Marr 646, August 9, 1939* (with *Anthelia julacea, Saccobasis polita, Jungermannia oblongifolia, Blepharostoma trichophyllum*. "On wet rocks beside stream, Ft. Chimo Air Base," Ungava Bay, *MLP-48-50, July 17, 1948* (with *Saccobasis polita*, traces of *Lophozia bantryensis, Bl. trichophyllum, L. floerkei*). "Wet sandy clay near the mouth of Great

Whale River," *Marr 663;* only a few plants among *Blasia pusilla.* (Material sterile: but pores, filaments of air-chambers, and ventral scales typical for *Preissia.*)

NORTHWEST TERRITORIES: "Crevices in dry arkose near Hudson's Bay Co. Post," Tukarak Island, Belcher Islands, *August 27, 1939* (with a few plants of *Sc. calcicola* var. *ligulifolia, Plagiochila asplenioides*).

74. Marchantia polymorpha L.

QUEBEC: Richmond Gulf, *Marr 677, 1939.* "On floor of spruce-larch woods, Papp's Point, mainland south of Cairn Island, Richmond Gulf," *Marr 641, July 27, 1939.* "Wet bog, Ft. Chimo Air Base," Ungava Bay, *MLP-48-20, July 10, 1948.* "Wet sandy soil, Ft. Chimo Air Base," *MLP-48-33, July 10, 1948.* "Moist grassy slope, north side of Leaf Bay, near the Narrows," Ungava Bay, *MLP-48-73.*

SUMMARY

In the preceding pages are reported 74 species of Hepaticae from the East Coast of Hudson Bay, from about lat. 54° N. (Cape Jones) north to lat. 60° N. Of these, 35 species have never been previously reported from the region, several are new to the general region, and a few are new to the mainland of North America. In addition, 4 species (*Calypogeia muelleriana, Jungermannia oblongifolia, Scapania degenii,* and *Scapania parvifolia*) are new to the New World, while a fifth form (*Scapania calcicola* var. *ligulifolia*) appears to be undescribed.

The region covered neatly fits between the region recently covered by Polunin (1947) and the region treated by Lepage (1945). Polunin assembled all previous reports of Hepaticae from the Canadian Eastern Arctic north of lat. 60° N. Lepage (1945) has treated southern Quebec, north to the Rupert River-Lake Mistassini region (i.e., north to lat. 52° N.) and (1944-1945) summarizes the distribution of all species known from Quebec. The interim region was covered partly by Wynne and Steere (1943) who reported 30 species of Hepaticae from the same general area treated here.

If the three lists of species (e.g., that of Polunin for the Arctic, the previous list for the region that is essentially on the border between arctic and subarctic, and that of Lepage, which includes largely subarctic species) are critically compared, certain interesting phytogeographical data emerge. These are, in spite of the extremely sketchy nature of the collections, reported on. In the following table these data are summarized, and the species are listed by several main groups:

I. DISTRIBUTION OF HEPATICAE IN CANADIAN EASTERN ARCTIC (AND SUBARCTIC BORDERLINE REGIONS)

—	Lepage (*circa* lat. 50° N.)	Schuster (lat. 54-58° N.)	Polunin (lat. 60-80° N.)
JUNGERMANNIAE			
JUNGERMANNIALES			
Jungermanninae			
Lophoziaceae			
Lophozia (O.) atlantica	x	x	x
" " binsteadii			x
" " floerkei		x	x
" " attenuata			x
" " quadriloba			x
" " kunzeana	x	x	x
Lophozia (B.) barbata	x	x	x
" " hatcheri		x	x
" " lycopodioides		x	x
Lophozia (M.) incisa	x		
" " grandiretis		x	
" " violascens			x
" " marchica			x
" " obtusa		x	x
Lophozia (L.) badensis			x
" " bantryensis		x	x
" " harpanthoides			x
" " heterocolpa		x	x
" " muelleri		x	x
Lophozia (D.) alpestris	x	x	x
" " longidens		x	
" " excisa			x
" " porphyroleuca			x
" " ventricosa		x	x
" " wenzelii		x	x
Lophozia (I.) bicrenata	x	x	
Gymnocolea inflata	x	x	x
Anastrophyllum michauxii	x		
" minutus	x	x	x
Temnoma setiforme		x	x
Saccobasis polita		x	x
Tritomaria scitula		x	
" quinquedentata		x	x
Mesoptychia sahlbergii			x
Jungermanniaceae			
Nardia geoscypha		x	
" scalaris			x
Jungermannia oblongifolia		x	
" pumilla	x		x
" sphaerocarpa			x
" atrovirens (incl. polaris)			x
Jamesoniella autumnalis	x		
Plectocolea crenulata	x		
" crenuliformis	x		
" hyalina	x		
" subelliptica		x	

I. DISTRIBUTION OF HEPATICAE IN CANADIAN EASTERN ARCTIC (AND SUBARCTIC BORDERLINE REGIONS)—*Continued*

——	Lepage (*circa* lat. 50° N.)	Schuster (lat. 54-58° N.)	Polunin (lat. 60-80° N.)
JUNGERMANNIAE—*Continued*			
JUNGERMANNIALES—*Continued*			
Jungermanninae—*Continued*			
Marsupellaceae			
Gymnomitrium concinnatum	.....	.....	x
" corralioides	.....	.....	x
" crenulatum	.....	.....	x
Marsupella emarginata	x	.....	x
" sparsifolia	.....	x	.....
" arctica (x groenlandica)	.....	x	x
Plagiochilaceae			
Plagiochila arctica	.....	.....	x
" asplenioides	x	x	x
Mylia anomala	x	x	.....
" taylori	x	x	.....
Lophocoleaceae			
Lophocolea minor	.....	x	.....
Harpanthaceae			
Geocalyx graveolans	.....	x	.....
Scapaniaceae			
Diplophyllum taxifolium	.....	x	.....
" apiculatum	.....	x	.....
" albicans	.....	x	.....
Scapania aequiloba	.....	.....	x
" aspera	.....	.....	x
" compacta	.....	.....	x
" degenii	.....	x	.....
" cuspiduligera	.....	x	x
" irrigua	x	x	x
" gymnostomophila	.....	x	x
" incurva	.....	.....	x
" calcicola var. ligulifolia	.....	x	.....
" parvifolia	.....	x	.....
" curta	.....	x	x
" paludicola	.....	x	x
" mucronata	.....	.....	x
" subalpina	.....	x	.....
" nemorosa	.....	.....	x
" simmonsii	.....	.....	x
" undulata	x	x	x
Southbyaceae			
Arnellia fennica	.....	.....	x
Cephaloziellaceae			
Cephaloziella alpina	.....	x	.....
" arctica	.....	x	.....
" elachista	.....	x	.....
" hampeana	.....	x	x

I. DISTRIBUTION OF HEPATICAE IN CANADIAN EASTERN ARCTIC (AND SUBARCTIC BORDERLINE REGIONS)—*Continued*

——	Lepage (*Circa* Lat. 50° N.)	Schuster (lat. 54-58° N.)	Polunin (lat. 60-80° N.)
JUNGERMANNIAE—*Continued*			
JUNGERMANNIALES—*Continued*			
Jungermanninae—*Concluded*			
Cephaloziellaceae—*Concluded*			
Cephaloziella elegans	.....	x?	.....
" rubella	.....	x?	x?
" starkei	.....	x	x
" biloba	.....	.....	x?
" bryhnii	.....	.....	x?
" grimsulana	.....	.....	x?
Cephaloziaceae			
Cladopodiella fluitans	.....	.....	x
" franciscii	x	.....	.....
Cephalozia ambigua	.....	x	x
" bicuspidata	x	x	x
" media	x	.....	x
" loitlesbergeri	.....	x	.....
" pleniceps	.....	x	x
" leucantha	.....	x	.....
" lammersiana	.....	x	.....
Odontoschismaceae			
Odontoschisma macounii	x	x	x
" elongatum	.....	x	.....
" denudatum	x	.....	.....
Hygrobiellaceae			
Anthelia juratzkana	.....	x	x
" julacea	.....	x	x
Pleuroclada albescens islandica	.....	x	x
Ptilidiinae			
Ptilidiaceae			
Ptilidium ciliare	x	x	x
" pulcherrimum	x	.....	.....
Blepharostomaceae			
Blepharostoma trichophyllum	x	x	x
" arachnoideum var. brevirete	.....	x	x
Lepidoziaceae			
Lepidozia reptans	x	x	.....
Microlepidozia setacea	.....	.....	x
Bazzania tricrenata	x	.....	x
Calypogeiaceae			
Calypogeia trichomanis	x	x	.....
" muelleriana	.....	x	.....
Porellinae			
Radulaceae			
Radula complanata	.....	x	.....

I. DISTRIBUTION OF HEPATICAE IN CANADIAN EASTERN ARCTIC (AND SUBARCTIC BORDERLINE REGIONS)—*Concluded*

	Lepage (*circa* lat. 50° N.)	Schuster (lat. 54-58° N.)	Polunin (lat. 60-80° N.)
JUNGERMANNIAE—*Concluded*			
JUNGERMANNIALES—*Concluded*			
Porellinae—*Concluded*			
Frullaniaceae			
Frullania bolanderi	x		
" tamarisci			x
METZGERIALES			
Pelliaceae			
Pellia epiphylla	x	x	
Aneuraceae			
Riccardia pinguis		x	x
" latifrons	x		
Blasiaceae			
Blasia pusilla		x	
MARCHANTIAE			
MARCHANTIALES			
Marchantiaceae			
Preissia quadrata	x	x	x
Marchantia polymorpha		x	x
Reboulliaceae			
Mannia pilosa			x
Asterella ludwigii			x
Cleveaceae			
Clevea hyalina			x
Sauteria alpina			x

II. PHYTOGEOGRAPHIC CONCLUSIONS

The Hepaticae known from the Canadian Eastern Arctic and from the northern edge of the Subarctic may be classified into the following vegetational elements:

(1) High or Strict Arctic (or Arctic-alpine).

(2) Arctic-alpine (with slight extensions or relict colonies in the Subarctic).

(3) Subarctic-Arctic or Subalpine-Alpine (e.g., with a range throughout most of the Coniferous regions and through at least the southern half of the Tundra region).

(4) Subarctic-subalpine (e.g., restricted to the Coniferous region; with a boreal distribution).

(5) Temperate (e.g., found in the Deciduous Forest regions chiefly or exclusively).

(6) Ubiquitous (with a wide latitudinal range, hence phytogeographically of little significance).

(7) Amphizonal (with two centres of distribution, one in the Arctic-alpine region, and one in the Deciduous, i.e., more southern region, but absent in the Coniferous intervening area; the term was coined by Reimers, 1940).

(8) Cordilleran or Western types.

These vegetational groups may be briefly discussed, individually, as follows:

1. High or Strict Arctic types (or Arctic-alpine)

Polunin (1947) reports from the region north of lat. 60° N. a considerable number of species with a restricted distribution of this type; most of these records are based on Bryhn and Kaalaas (1906). Among the species listed are the following, which have a nearly exclusively Arctic distribution:

Lophozia quadriloba, L. violascens, L. harpanthoides, Mesoptychia sahlbergii, Gymnomitrium crenulatum (and probably *concinnatum* and *corralioides*), *Plagiochila arctica, Scapania simmonsii, Anthelia julacea, Blepharostoma arachnoideum* var. *brevirete, Sauteria alpina.* To these species I would add, on the basis of the previous collections reported on, the following species, which are from the region between 52° and 58° N.:

Jungermannia oblongifolia, Marsupella arctica (*groenlandica*), *Cephaloziella arctica, Pleuroclada albescens* var. *islandica, Anthelia julacea, Blepharostoma arachnoideum* var. *brevirete.*

2. Arctic-alpine types (with a slight extension or relict distribution in the Subarctic)

A relatively large number of species are to be classed here. Polunin (1947) reports from the region northward from lat. 60° N. the following species, in my estimate with a distribution pattern of this type:

Lophozia atlantica, binsteadii, floerkei, hatcheri, heterocolpa, lycopodioides, bantryensis, obtusa, wenzelii, Temnoma setiforme, Saccobasis polita, Jungermannia sphaerocarpa, atrovirens (including *polaris*), *Cephalozia ambigua, Odontoschisma macounii, Anthelia juratzkana, Asterella ludwigii.*

On the basis of collections reported on in the previous pages, I would list the following species, found between lat. 52° and 58° N., under this category. Many of these are the same as reported by Polunin, but a few represent additions:

Lophozia atlantica, floerkei, hatcheri, heterocolpa, lycopodioides, grandiretis, bantryensis, obtusa, wenzelii, Temnoma setiforme, Saccobasis polita, Tritomaria scitula, Marsupella sparsifolia, Mylia taylori, Scapania degenii, Sc. cuspiduligera, gymnostomophila, calcicola var. *ligulifolia, Cephaloziella alpina, Cephalozia ambigua, Odontoschisma macounii, elongatum, Anthelia juratzkana.*

3. Species with a distribution covering most of the Arctic-alpine and Subarctic-subalpine regions

The following species of this category are listed by Polunin (from the region of the Arctic from lat. 60° N.):

Lophozia attenuata, L. marchica, L. badensis, L. muelleri, alpestris, excisa, ventricosa, Gymnocolea inflata, Anastrophyllum (*Sphenolobus*) *minutus, Tritomaria quinquedentata, Jungermannia pumilla, Scapania irrigua, S. curta, paludicola, mucronata, subalpina, undulata, Cladopodiella fluitans, Cephalozia bicuspidata, C. pleniceps, Ptilidium ciliare, Blepharostoma trichophyllum, Bazzania tricrenata, Frullania tamarisci, Preissia quadrata.*

Of the species found between lat. 52° and 58° northward, I believe the following should be classed here:

L. muelleri, alpestris, ventricosa, Gymnocolea inflata, A. (S.) *minutus, Tritomaria quinquedentata, Plectocolea subelliptica, Mylia taylori, Diplophyllum taxifolium, albicans, Scapania parvifolia, Cephaloziella elachista, alpina, Cephalozia leucantha, loitlesbergeri, lammersiana, Ptilidium ciliare, Blepharostoma trichophyllum, Preissia quadrata.*

4. Species nearly or quite restricted to the Boreal (Subarctic-subalpine) region

Only a few species are mentioned by Polunin (1947) with this type of distribution, that occur north of lat. 60°; the only species that probably should be classed here is *Marsupella emarginata.*

Among the collections examined from the region lying between lat. 52° and 58° N. are, understandably, a larger number of species of this type:

Lophozia longidens, L. bicrenata, ?Nardia geoscypha, Mylia anomala, Geocalyx graveolans, Lepidozia reptans, Calypogeia muelleriana.

Lepage (1945) mentions a few more, from the Rupert River–Lake Mistassini Area, as follows:

Lophozia incisa, Anastrophyllum michauxii, Jamesoniella autumnalis, Marsupella emarginata, Mylia anomala, Cladopodiella franciscii, Ptilidium pulcherrimum, Lepidozia reptans, Riccardia latifrons.

5. Species essentially of Temperate Zone distribution (rarely found north of the Deciduous Forests)

None of the species listed by Polunin (1947) fall here, as would be expected.

Of the species reported from the region between lat. 52° and 58° N., only the following are to be classed here:

Lophocolea minor, Diplophyllum apiculatum, ?Calypogeia trichomanis, Radula complanata, Blasia pusilla.

Lepage (1945) lists one or two species more: *Plectocolea crenulata, ?crenuliformis, hyalina, Odontoschisma denudatum, ?Calypogeia trichomanis.*

6. Ubiquitous Species

A number of species listed (from the three regions) have such a broad distribution that they are not significant for the present discussion. Here fall:

Plagiochila asplenioides, Cephaloziella hampeana, starkei, rubella, Cephalozia media, Pellia epiphylla, Riccardia pinguis, Marchantia polymorpha.

7. Amphizonal Species (types found in the Temperate region and again in the Arctic-alpine, but not in the intervening territory)

Although few, the species with a range of this type are extraordinarily interesting. As is to be expected, more species of this type are to be found among the lower forms than among vascular plants, for the following reasons:

(a) A greater ecological amplitude, e.g., somatic plasticity, of the Bryophytes, and inversely,

(b) A lesser degree of genetic variability and probably lower rate of evolution (compared with vascular plants).

Reimers (1940) has discussed here *Clevea hyalina* and *Asterella saccata* and their range in Europe. The writer (Schuster, 1951) discusses these and several other species with a similar distribution (*Mannia pilosa, M. sibirica*). It has been found that the essentially Arctic-alpine *Clevea hyalina, Asterella saccata, Mannia pilosa*, and *M. sibirica* have a relict distribution in the Temperate Regions (south of the boundaries of the Pleistocene glaciers, in some cases), and then occur again, more commonly, in the Far North.

The writer (1951) reports all four of these species from the unglaciated area (the "Driftless Area") of southeastern Minnesota, far south of the region here under discussion. Significantly, neither Lepage (1945), Wynne and Steere (1943), nor the writer in the present study, has found even one of these species in the region from about lat. 50° to 60° N. *Mannia pilosa* and *Clevea hyalina* are, however, reported by Polunin from the Far North, under strict Arctic-alpine conditions.

The few species in this class have their present distribution probably because of the Pleistocene glaciation. As is well known and as has been emphasized by Fernald (1925) (*See* next section), the northern part of the Canadian Eastern Arctic was not glaciated or submerged since at least the

Tertiary. The Arctic species discussed above, therefore, could have survived in the Far North. Their present occurrence in Ellesmereland and Baffinland, etc., may, therefore, be pre-glacial. With the southward advance of the glaciers a similar (but relatively temporary) environment was created near the southern edge of the advancing glaciers, and these species, which, it should be emphasized, are pioneers, appear to have migrated southward, finding a refugium in the Driftless regions immediately below the glacial fields and lobes. With the retreat of the ice, these species have been localized, in a few restricted niches, in a region that to-day is climatically far from optimum for them. The occurrence of *Clevea hyalina* and *Mannia pilosa* to-day in the "Nunatak" of the Gaspé (*See* Lepage, 1945) in the similarly unglaciated enclave of the "Driftless" area in Minnesota, and again in the high Arctic regions, can scarcely be explained in any other way.

There are several other species, with an extremely puzzling distribution, that are also in one sense amphizonal species (but perhaps for entirely different reasons). These species appear to be Pre-Tertiary relict species, whose centre of distribution, to-day, is southern Europe and the low mountains fringing the Mediterranean and to a lesser degree, the Alps. These include three *Scapania* species (*aequiloba*, *aspera*, *compacta*) reported by Polunin (1947) from the Canadian Arctic, north of lat. 60° N. This vegetational element, essentially of southern affinity (with isolated, disjunct restricted sites in the high Arctic), thus has essentially the inverse distribution as compared with the previous groups of species. The reasons for their amphizonal distribution also appear to lie back much farther in geological history.

Buch (1928) states "*Sc. compacta* ist ein atlantisches Moos südlicher Abstammung" (Tunis, Madeira, and Teneriffe, on the Atlantic Coast to Great Britain, France, Belgium, upper Italy, and in the lower mountains of Central Europe and in the north-German flatlands). The species again occurs in Greenland (fide K. Müller, leg. Breutel) and on Southampton Island (South Bay) (fide Jennings, 1936, p. 15). Buch (l.c.) also states that "*Sc. aequiloba* ist wahrscheinlich eine sehr alte, aus Südeuropa stammende, kalkholde Berglandpflanze, die vielleicht schon vor der Eiszeit an die Westküste Norwegens gelangte . . . Unerklaerlich ist das isolierte amerikanische Vorkommen" (Ellesmereland).

S. aspera has a somewhat broader range, occurring from Dalmatia, Sicily, and Sardinia, north through the mountains of central Europe, with isolated stations in Scotland, Scandinavia, and Gotland. It recurs again, at a single station, in the Canadian Eastern Arctic (Clyde, Central Baffin Island, leg. Polunin, fide Sherrin; *see* Polunin, 1947).

The distribution of these three essentially southern species is strangely suggestive of the early distribution of *Sequoia*, *Magnolia*, and other early types of Conifers and Angiosperms. Is it possible that the existing restriction of distribution into two centres (the unglaciated Canadian Arctic and the region fringing the Mediterranean) represents an extremely circumscribed and restricted relict distribution, the result of destruction of much of the earlier range that embraced much of the intervening territory? Certainly the existing restriction of these species to

two unglaciated centres, at a vast distance to each other, suggests that their occurrence to-day is preglacial and that (as Buch suggests for *S. aequiloba*) the species are extremely ancient.

8. Species essentially Cordilleran in distribution or occurring largely on the Pacific Coast

Only two species should be mentioned here: *Blepharostoma arachnoideum* var. *brevirete* and *Frullania bolanderi*. The typical forms of both species are widespread along the Pacific Coast (from California to British Columbia). The writer (Schuster, 1951) will discuss the case of *F. bolanderi* in some detail, and concludes that the species was at one time probably transcontinental in range. It occurs to-day in a well-defined centre radiating out from the "Driftless" area of Minnesota and Wisconsin and has populated (from there) the Great Lakes region of Michigan, Wisconsin, Minnesota, and Ontario. It recurs again, apparently commonly, in Quebec (Rupert River at Plum Pudding Portage and farther southward at Cap à l'Aigle, Montagne du Collège de Sainte-Anne, at Bic, at Rimouski, at Sainte-Irène, Matapedia) (Lepage, 1945). There are also scattered localities southward in Maine (Canton). The eastern existing range appears to radiate out from the unglaciated Gaspé Peninsula or perhaps from the unglaciated Appalachians (though unknown from there to-day). The *Frullania*, unlike the *Blepharostoma*, is apparently a Temperate Zone species, which occurs normally on the bark of trees. If it ever had any extensive range farther northward, this obviously was destroyed during the Pleistocene glaciation. The species obviously could scarcely have survived in the unglaciated high Arctic regions.

Blepharostoma arachnoideum has a different distribution pattern: it has a widespread Cordilleran distribution and has been known (elsewhere) only from Ellesmereland (from which it was described by Bryhn and Kaalaas, 1906, as a variety, *brevirete*, of the widespread *Bl. trichophyllum*). In my estimate *brevirete* is doubtfully distinct from typical *arachnoideum*. I have found material of this species also in a collection from Belcher Islands, Northwest Territories. The range of this species seems to radiate out from the unglaciated (or locally glaciated) Pacific Coast region and from the unglaciated high Arctic region; in locations within both areas it still occurs. The Belcher Island occurrence is certainly postglacial, since these islands were submerged in immediately postglacial times. *Blepharostoma arachnoideum*, therefore, also appears to have had a broader transcontinental distribution in preglacial times.

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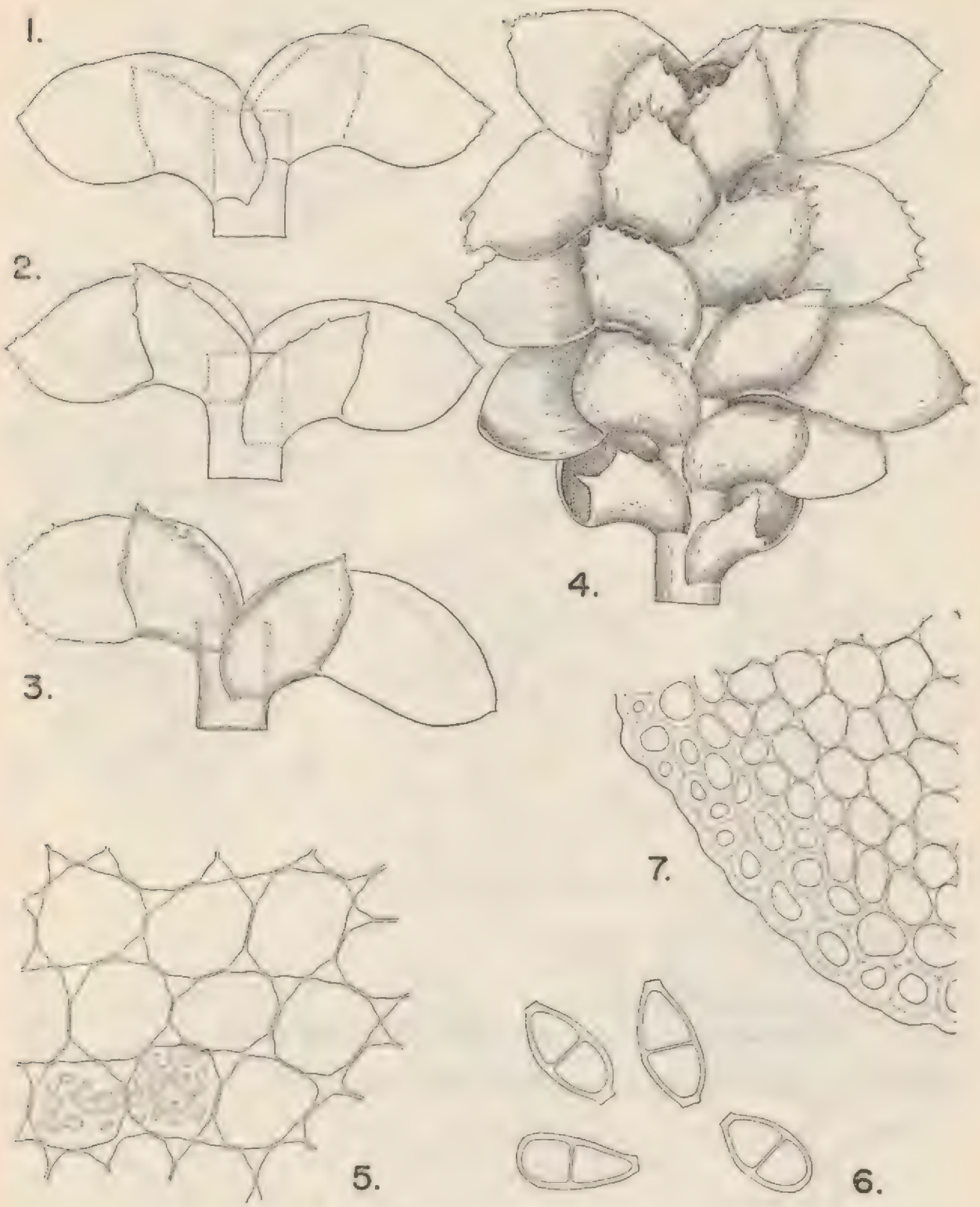
PLATE I

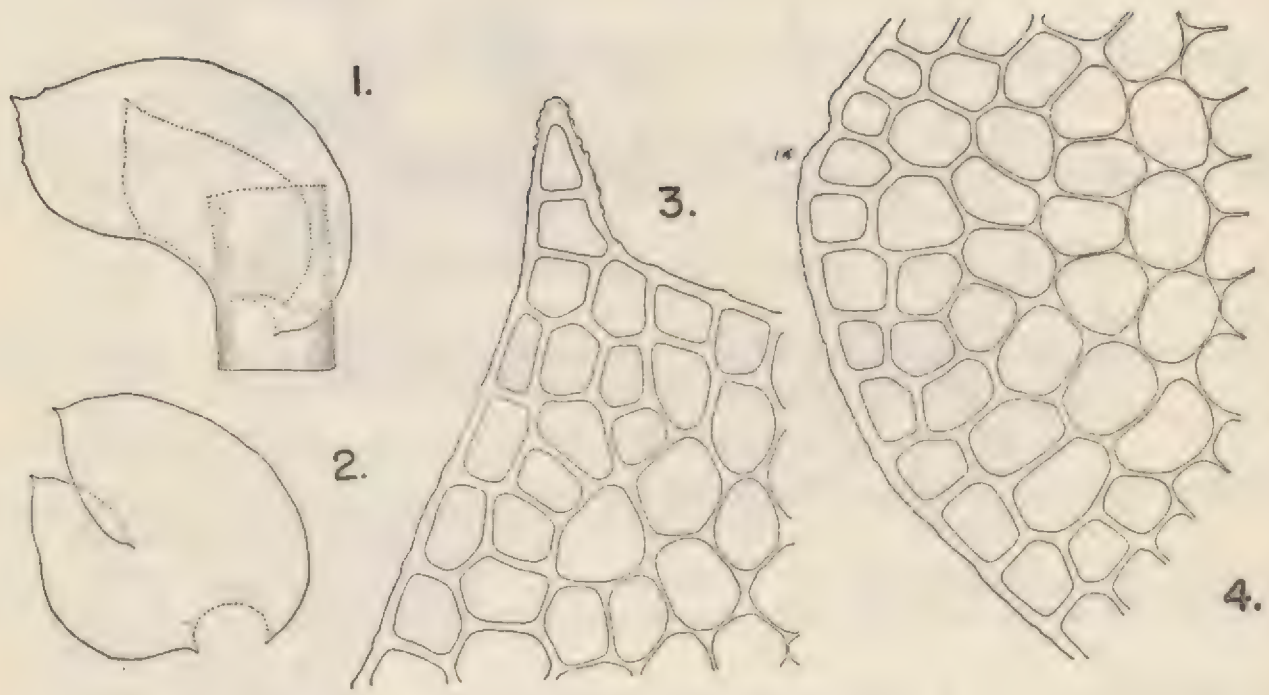


Scapania parvifolia

Figure 1. Part of shoot, with two leaves, ventral view (*x* 26).
Figure 2. Part of shoot, with two leaves, ventral view (*x* 26).
Figure 3. Part of shoot, with two leaves, dorsal view (*x* 26).
Figure 4. Gemmiparous shoot (*x* 31).
Figure 5. Cells of leaf-middle, on two cells with cuticular papillae stippled in (*x* 500).
Figure 6. Gemmae (*x* 600).
Figure 7. Part of stem, cross-section (*x* 360).

(All drawn from *Marr 655c*, from Great Whale River, Quebec.)

PLATE II



Scapania parvifolia

Figure 1. Ventral view of leaf (*x* 35).

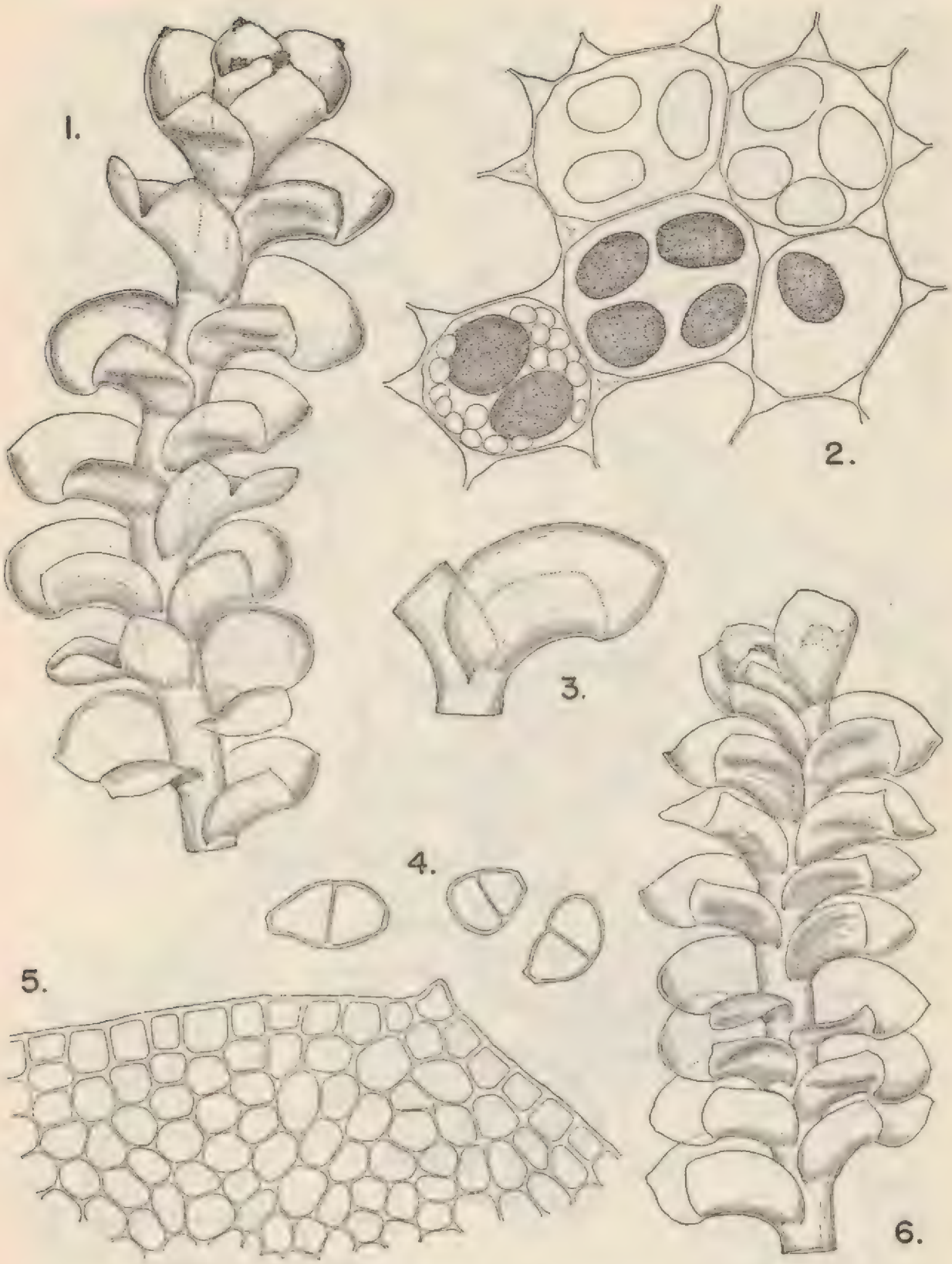
Figure 2. Leaf, flattened out (*x* 32).

Figure 3. Dorsal leaf apex (*x* 465).

Figure 4. Ventral lobe apex, the apex indicated by an asterisk (*x* 465).

(All drawn from *Marr 655c*, from Great Whale River, Quebec.)

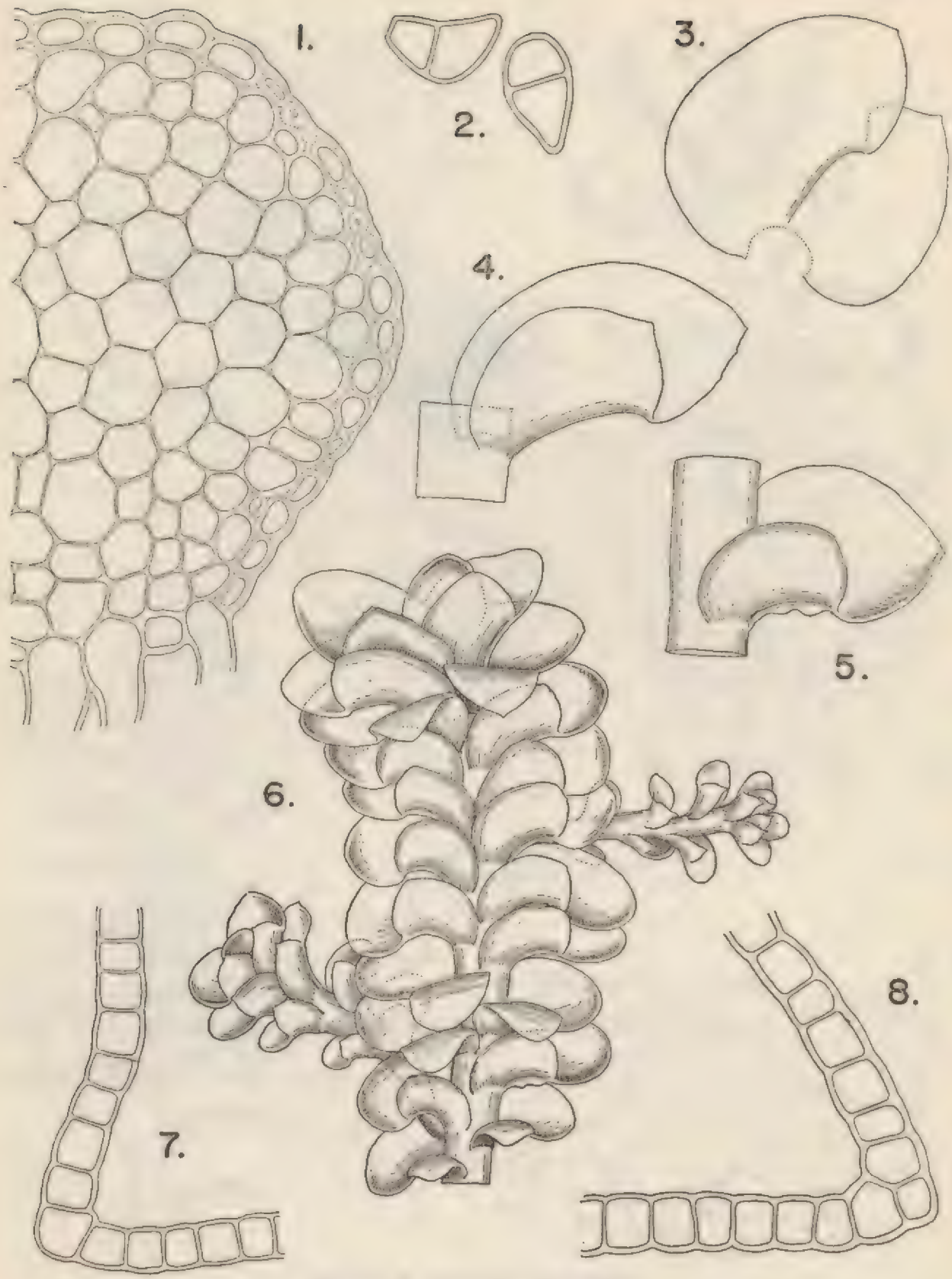
PLATE III



Scapania calcicola var. *ligulifolia*

Figure 1. Gemmiparous plant (*x* 20).
Figure 2. Cells of leaf-middle, with chloroplasts indicated on left cell, oil-bodies in other cells (in that of lower right only one drawn in) (*x* 800).
Figure 3. Leaf, ventral view (*x* 26).
Figure 4. Gemmae (*x* 440).
Figure 5. Apex of ventral lobe, showing border of thick-walled cells (*x* 265).
Figure 6. Gemmiparous plant (*x* 20).

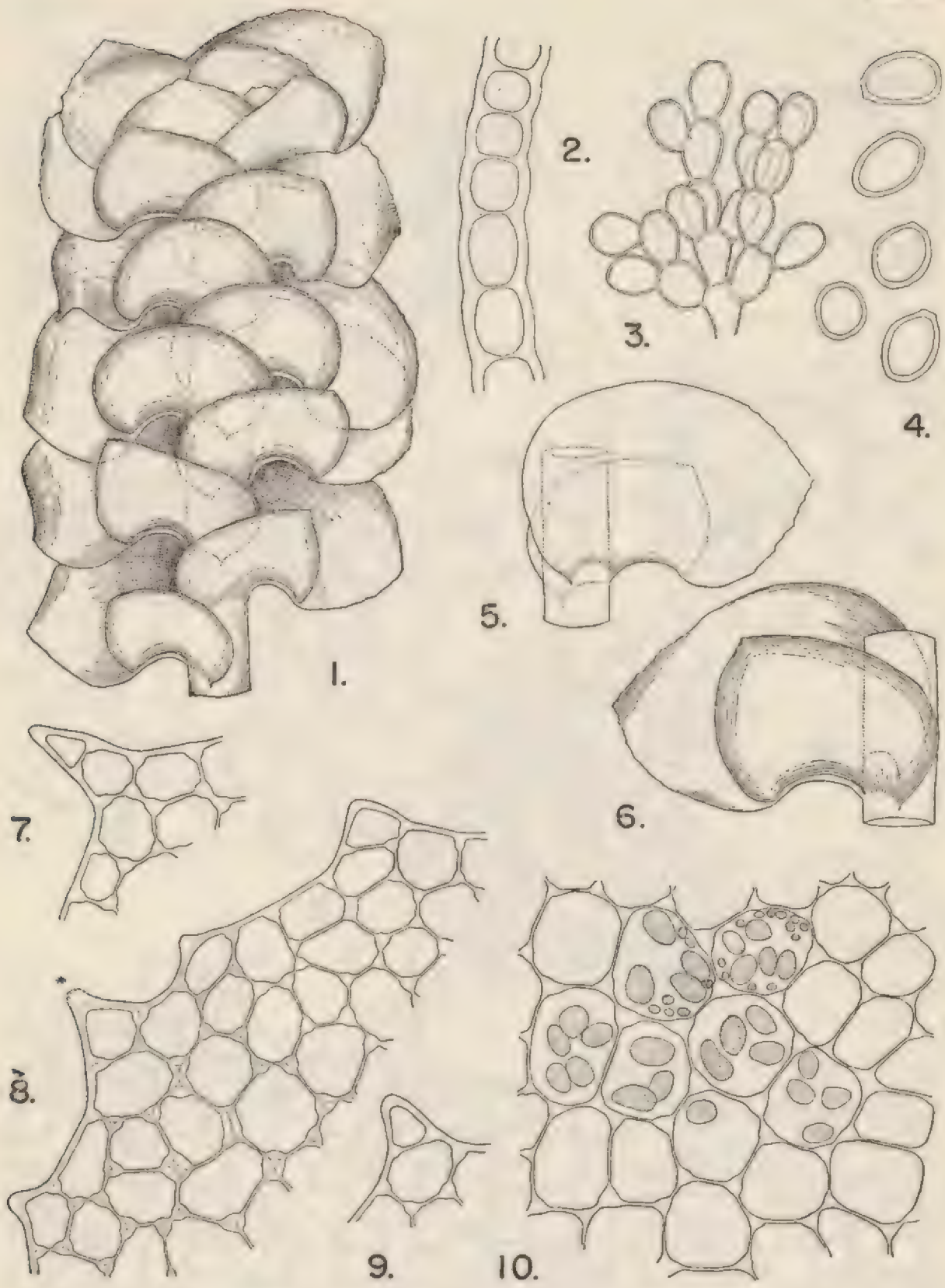
(All drawn from *Marr 667b*, Tukarak Island, Belcher Islands, N.W.T.)



Scapania calcicola var. *ligulifolia*

Figure 1. Stem cross-section (*x* 360).
Figure 2. Gemmae (*x* 440).
Figure 3. Leaf, flattened out (*x* 26).
Figure 4. Leaf (*x* 26).
Figure 5. Leaf (*x* 35).
Figure 6. Non-gemmiparous shoot of mod. *densifolia* (*x* 20).
Figures 7-8. Cross-sections of keel of leaves (*x* 240).

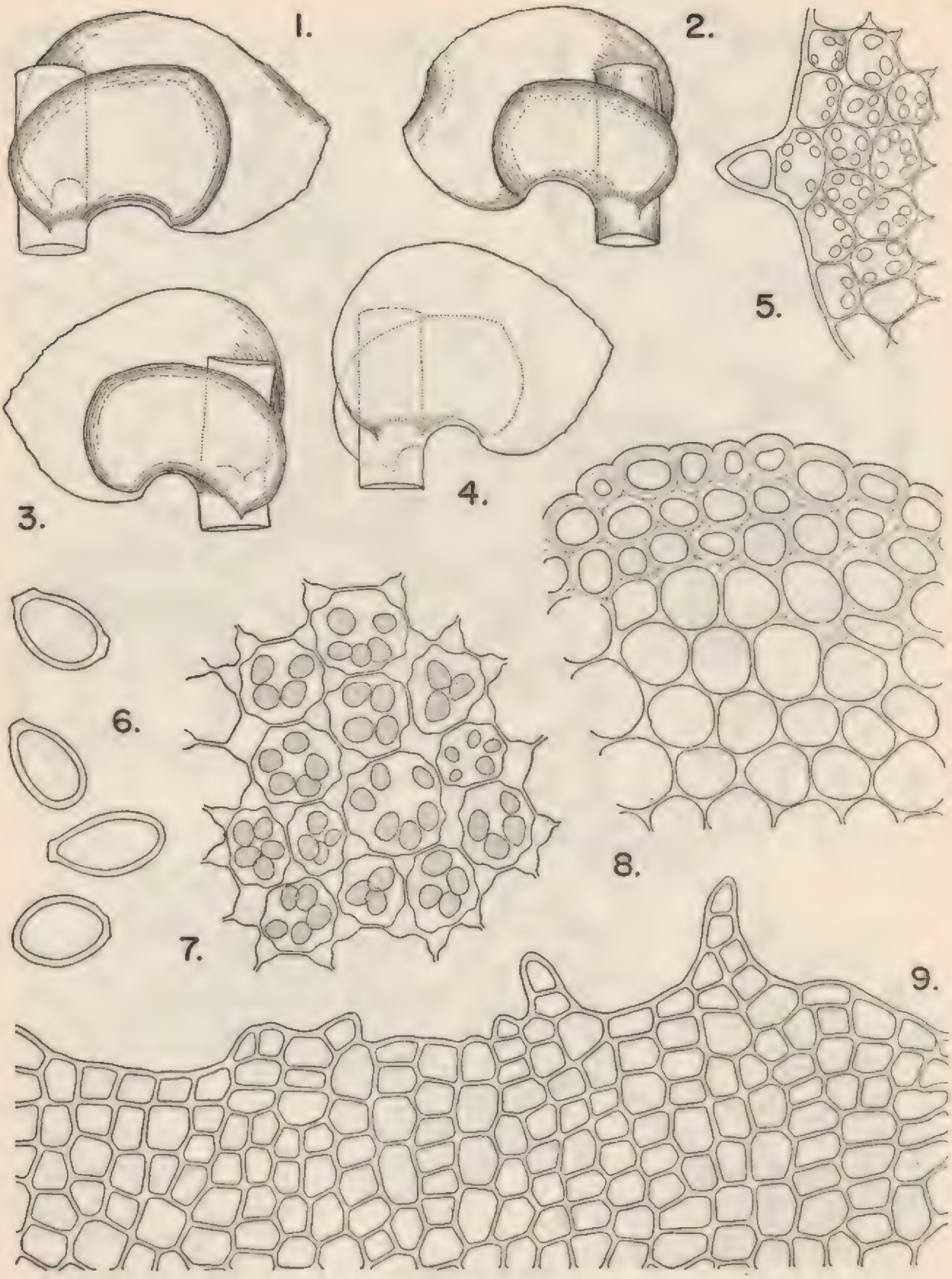
(All drawn from *Marr 667b*, Tukarak Island, Belcher Islands, N.W.T.)



Scapania degenii

Figure 1. Non-gemmiparous shoot (*x* 18).
Figure 2. Leaf-section (*x ca.* 300).
Figure 3. Gemma fascicle (*x* 300).
Figure 4. Free mature gemmae (*x* 450).
Figures 5-6. Leaves (5 ventral, 6 dorsal view) (*x* 24).
Figures 7-9. Apices of ventral leaf-lobes (*x* 300).
Figure 10. Cells of leaf-middle; oil-bodies drawn in 6 cells; chloroplasts drawn in 2 cells (*x* 500).
(All drawn from *Marr 669*, Flaherty Island, Belcher Islands, N.W.T.)

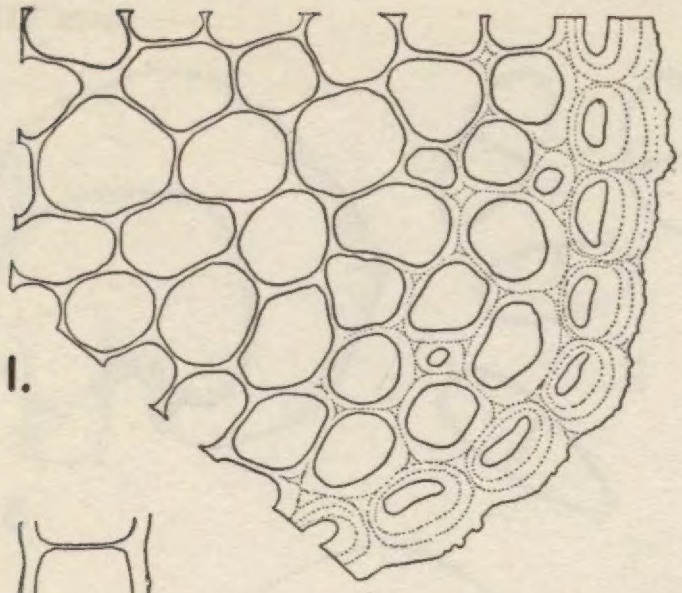
PLATE VI

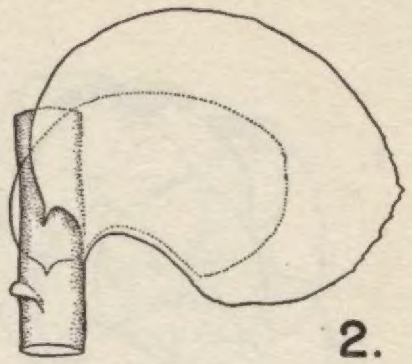


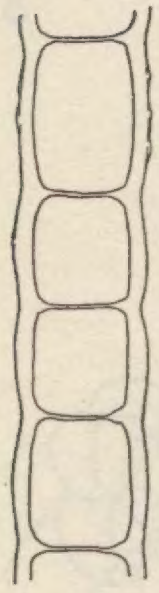
Scapania degenii

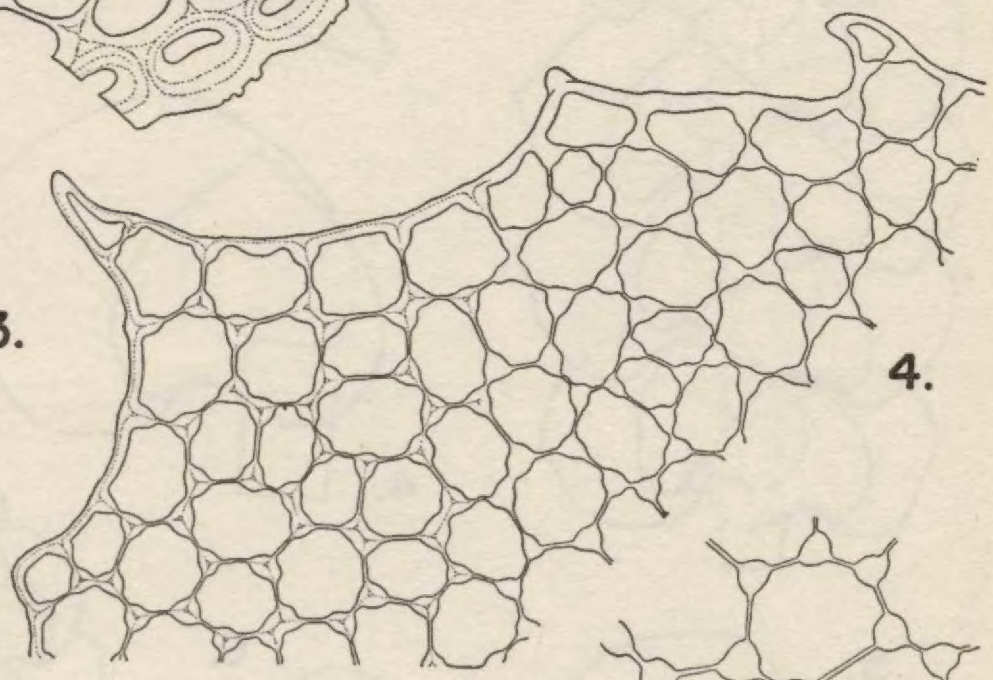
Figures 1-4 Leaves; (1-3 dorsal; 4 ventral view) (*x* 20)
Figure 5. Marginal leaf-cells, showing oil-bodies (*x* 280).
Figure 6. Gemmae (*x* 600).
Figure 7. Cells of leaf-middle, showing oil-bodies (*x* 500).
Figure 8. Part of stem cross-section (*x* 250).
Figure 9. Cells of perianth-mouth (*x* 240).

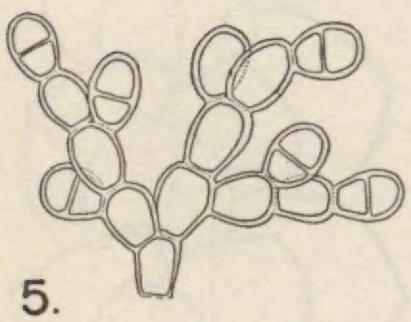
(Figures 1-5, 7-8 from *Marr 669*, Flaherty Island, Belcher Islands, N.W.T.; Figures 6, 9 from *Schuster 1359*, Temperance River, Cook County, Minn.)

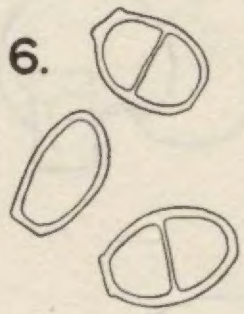


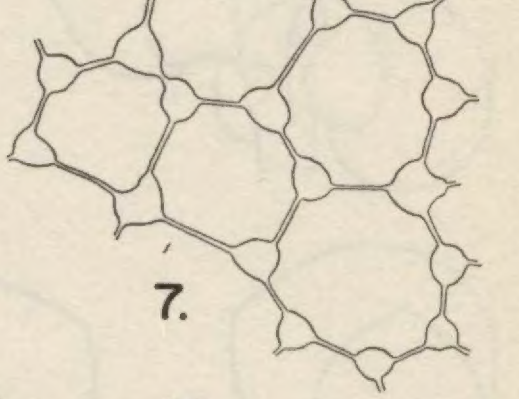


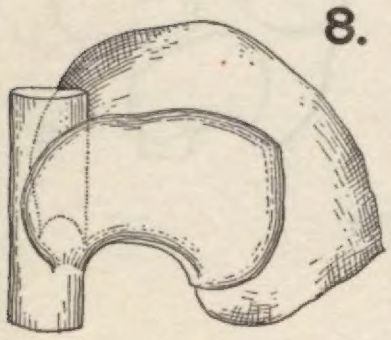


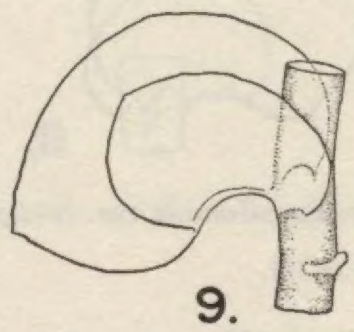


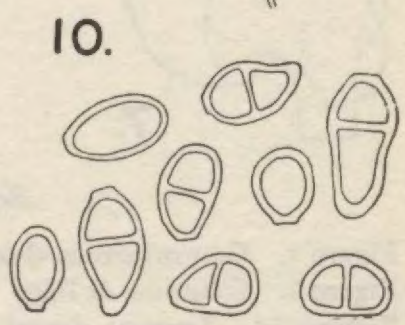










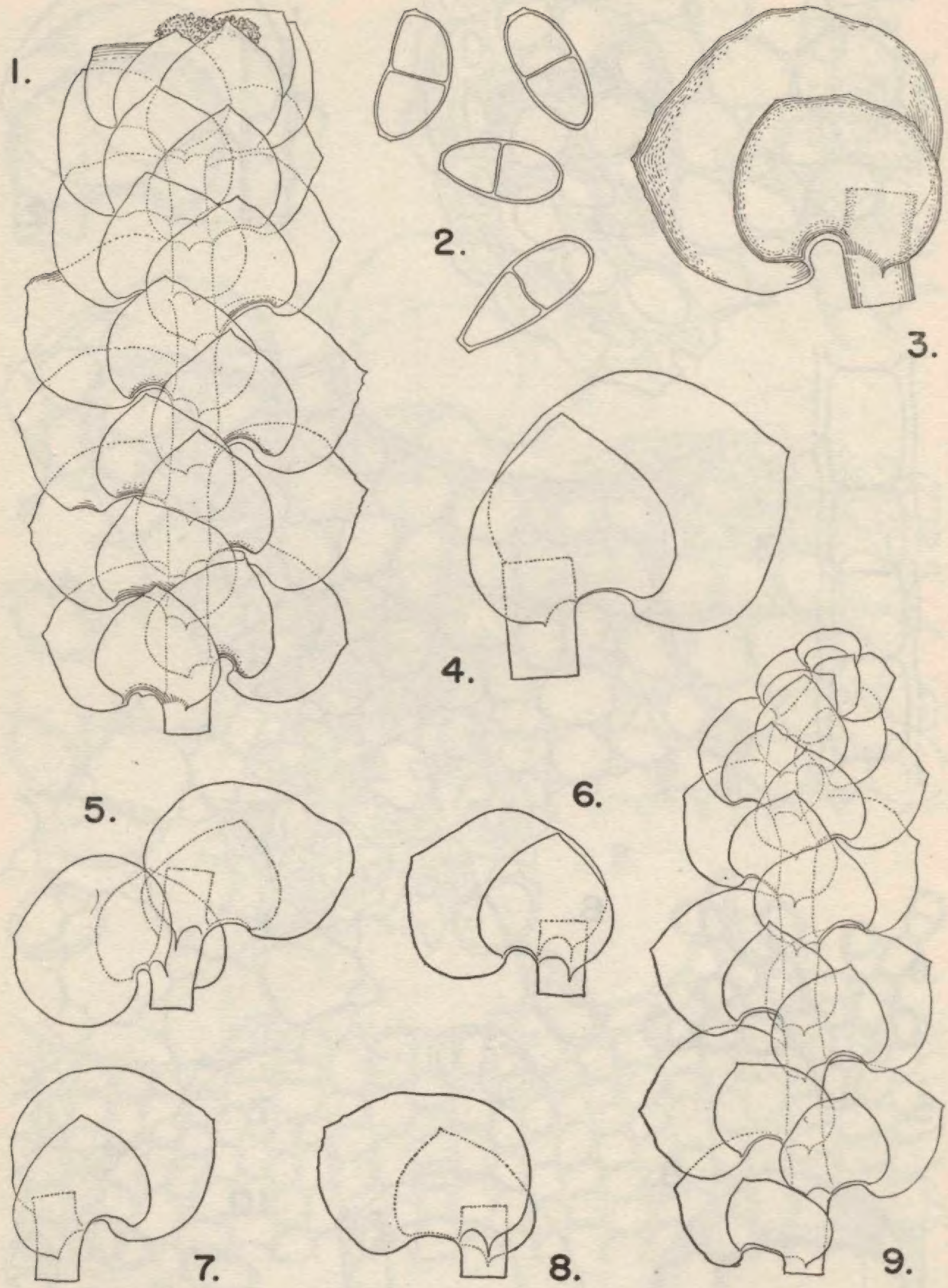


Scapania hyperborea

Figure 1. Part of stem cross-section (*x* 360).
Figure 2. Leaf (*x* 20).
Figure 3. Leaf cross-section (*x ca.* 550).
Figure 4. Apex of ventral lobe (*x* 360).
Figure 5. Gemma fascicle (*x* 300).
Figure 6. Mature gemmae (*x* 600).
Figure 7. Cells of leaf-middle (*x* 600).
Figures 8-9. Two leaves, dorsal view (*x* 20).
Figure 10. Gemmae (*x* 450).

(Drawn from material collected by the writer on the Susie Islands, Cook County, Minn.)

PLATE VIII



Scapania paludicola var. *viridigemma*

Figure 1. Gemmiparous shoot (*x* 12).
Figure 2. Gemmae (*x* 700).
Figures 3-4. Leaves; dorsal view (*x* 18).
Figures 5-8. Leaves with parts of shoots, 5 and 8 ventral view, 6-7 dorsal view (*x* 12).
Figure 9. Smaller, non-gemmiparous shoot (*x* 12).

(All drawn from *Marr 657*, Great Whale River, Quebec.)